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ELECTRONIC COMPUTER PROGRAMMING INSTITUTE

I·B·M Data Processing and
Computer Programming Course

STUDY UNIT III
LESSON 8 - 9 - 10

I.B.M. DATA PROCESSING
AND COMPUTER PROGRAMMING

LESSON No. 8

TABLE OF CONTENTS

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8.1 Introduction to the Reproducer

So far we have studied one method used to create IBM cards, the IBM type 024 key punch. This is the one machine which can perform the function of punching holes in IBM cards. There are many occasions when we wish to punch additional information in cards which have already been key punched, or when, given a deck of key punched cards, we wish to create another deck, exactly like the original, or consisting only of some of the fields found in the original. We have a means of creating cards or punching information into cards automatically — by using the IBM type 514 Reproducer.

We will find when studying the Reproducer, that the operation of this machine, like the operation of the IBM 552 Interpreter, is determined by a control panel. We will again see how X-Eliminators are used; in addition to the control panel

principles you already know, we will introduce two new concepts, comparing and emitting. These should offer little difficulty if you understand those features of control panel wiring discussed to date.

There are three main functions of the type 514 Reproducer:

1. Gang Punching
2. Reproducing
3. Comparing.

We are going to study each of these functions in turn. Before going on into a discussion of our first basic function, gang punching, let us examine the operating characteristics of the Reproducer which are important to an understanding of the gang punch function.

8.2 Operating Characteristics of the 514 Reproducer

Figure 1 is an illustration of the Reproducer. We are going to discuss some of the operating characteristics of this machine at this point. Only those operating characteristics which are important insofar as the gang punching function is concerned will be discussed here: The balance of the operating characteristics of this machine will be discussed in a later lesson.
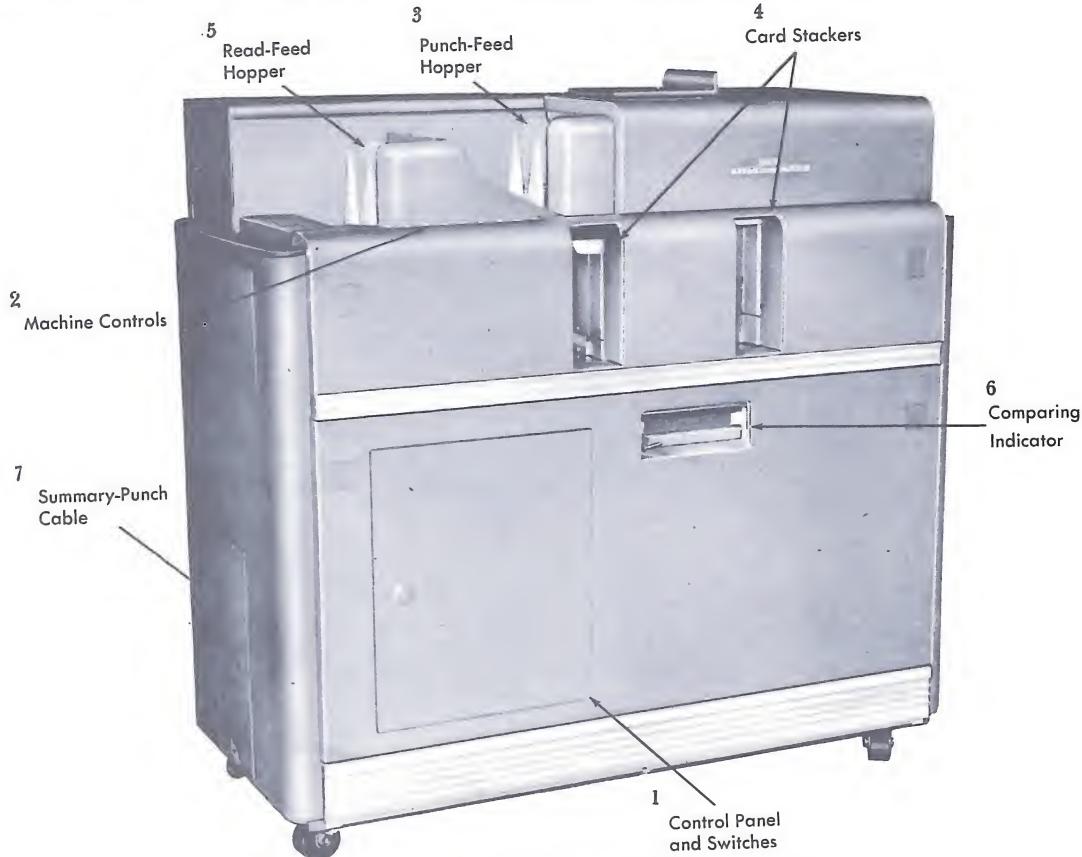

Figure 1. The IBM type 514 Reproducer

1. *Control Panel* — the control panel is inserted in a rack which is to be found behind this door. An illustration of the control panel in the rack and the various switches which control the operation of the Reproducer will be found in Figure 2.

2. *Machine Controls* — the two keys used to start and stop feeding are on the right of Figure 3. The main line switch, which controls electrical power, is to be found on the right hand side of the machine, but cannot be seen in this illustration.
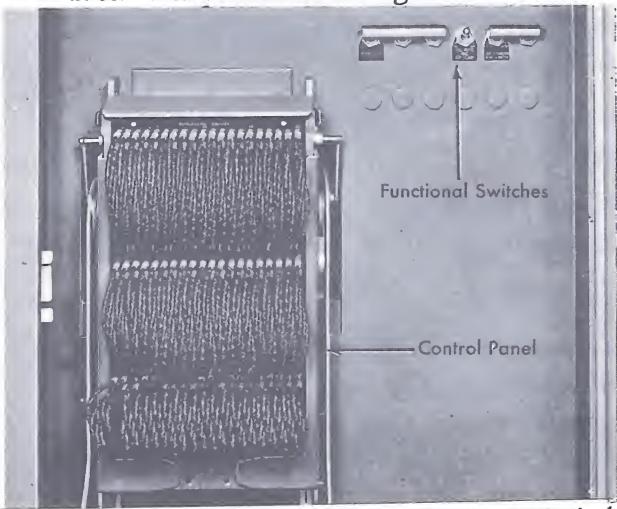

Figure 2. The Control Panel and Functional Switches

Figure 3. Machine Controls

3. *Punch-Feed Hopper* — there are two feeds in the Reproducer. The one we will be concerned with initially is the punch unit feed. Cards are placed in this feed face down, 12 edge in. They are first joggled using the "joggle plate" located just to the right of the punch unit feed.

4. *Card Stackers* — after cards are processed they pass into the stackers. Cards processed through the punch unit feed are stacked in the stacker located on the right side of the machine.

5. The reproducer operates at the speed of 100 cards per minute.

There is very little about the machine's operation that can be seen just by looking at the machine. Cards are placed in the Punch Unit Feed, the Start key is depressed, cards are fed through the machine and enter the card stacker. The processing of the card on its journey through the machine is determined by the wiring of the control panel.

8.3 Gang Punching

Sometimes we wish to punch the same piece of information into a group of cards. We punch it into one card manually using the key punch. This manually punched card is called a master card. Then we use the reproducer to "copy" the information from the master card into all the other cards (called detail cards).
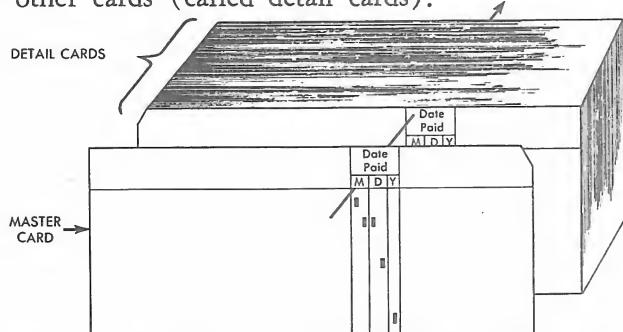

Figure 4. Master and Detail cards for gang-punching

We place the master card in front of the detail cards and place them all in the Punch-Feed Hopper. The reproducer will punch the information from the first card (the master card) into the second card; from the second card into the third card into the fourth card, etc.

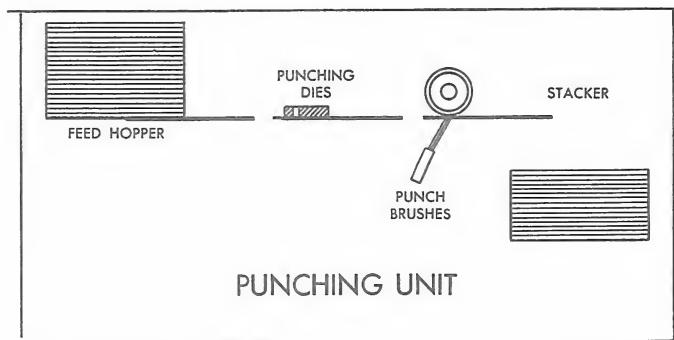Let us examine the schematic of the punch unit (this is the unit fed by the punch unit feed).

Figure 5. Schematic of the punching unit

As the cards leave the Punch-Feed Hopper, they pass under a station in the machine called the "punching dies". We discussed the concept of the "punching die" in the key punch lesson. The die is the device which punches the card. In the key punch we had a single die as the key punch punches one column at a time. In the reproducer, we have 80 punching dies, one for each column in the card. All columns are punched at once.

The next station in the punch unit is called the "punch brushes." Here we have 80 brushes, one for each column. In gang punching, information read from the card which is passing under the punch brushes is punched into the card which is passing under the punching dies.

Let's try a simple problem and trace the path of the cards through the machine. Then we will look at the control panel wiring required to do the problem. You are given a deck of cards and told to punch the date 12/31/60 into c.c. 75-80. You go to the key punch and create a master card which has in c.c. 75-80 the digits 123160. This card (called the master card) is placed in front of the deck to be punched (called the detail cards.)

Now the theory behind gang punching is that information read from the card by the punch brushes is punched back into the card passing under the punching dies. Let us trace the path of our cards through the machine to see how gang punching works. See Figure 6.

1. On the first machine cycle, our master card will pass under the punching dies. Since there is no card at the punching brushes at this time, nothing will be punched in the master card.

2. On the second machine cycle, the master card will pass under the punching brushes and the first detail card will pass under the punching dies. The information in 75-80 of the master card will be read by the punching brushes and transmitted back to the
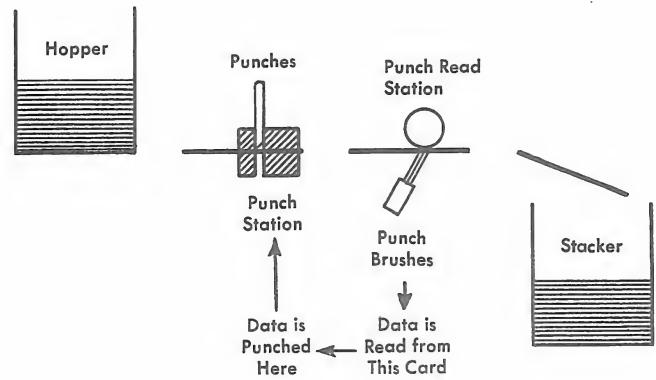

Figure 6. How gang punching is performed

punching dies where it will be punched into the first detail card. Now both the master card and the first detail card have 123160 in c.c. 75-80.

3. On the third machine cycle, the first detail card will pass under the punching brushes, the second detail card under the punching dies, and the master card will enter the stacker. The machine will read the information in c.c. 75-80 from the first detail card and punch it back into the second detail card. From this point on, the third detail card will punch back into the fourth, the fourth into the fifth and so on until all the detail cards have been punched.

Figure 7 illustrates the control panel diagram for gang punching c.c. 75-80.

INTERNATIONAL BUSINESS MACHINES CORPORATION
513—514 AUTOMATIC REPRODUCING PUNCH, CONTROL PANEL
FOR SUMMARY PUNCHING — ALPHABETIC ACCOUNTING MACHINE

Form X24-9188-9
Printed in U.S.A.

REPRODUCING BRUSHES

D. P. & BL. COL. DETECTION — COLUMN — SPLITS

G. P. EMITTER

CTR. COL. — RX — RD — PX — PD

O & X — READ X BR. — MX

PUNCH MAGNETS

P. X. BR. — M. S. BRUSHES

PUNCH BRUSHES

SELECTOR 1 — SELECTOR 2

SUM. X PCH. CTRL. OR M. S. BRUSHES

COMP. MAG. FROM PUNCH BRUSHES

COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN

COMP. MAG. FROM COMPARING BRUSHES

COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT

COMPARING BRUSHES

DEPT. NO. NAME USE

Figure 7.

Inserting the control panel in the 514

Notes on Figure 7:

1. Information read by the punch brushes is available from the Punch Brush hubs (Q-T, 1-20). These are exit hubs.

2. The 80 punching dies are represented by the hubs labelled Punch Magnets (K-N, 1-20). These are entry hubs.

3. The wiring necessary to gang punch c.c. 75-80 is indicated here. We wire from Punch Brushes 75-80 to Punch Magnets 75-80. Impulses read by the Punch Brushes are transmitted back to the Punch Magnets (to activate the punching dies). Again, the "time" the impulse reaches the punching dies tells the machine what zone to punch.

4. Refer back to Figure 2. You will note the functional switches in the upper right hand portion of this illustration. For the gang punch operation, all functional switches are OFF (in the up position, as illustrated).

5. Gang punching is verified by sight checking the cards through the columns gang punched. This is a concept we discussed in the lesson on the 082 sorter. If the machine has functioned properly, the punched 123160 should be in c.c. 75-80 of all cards. By joggling them to make them square and holding them up to the light, we should be able to "sight" them. Another way to verify gang punching is to check the last card to see that it agrees with the master card. See Figure 8.
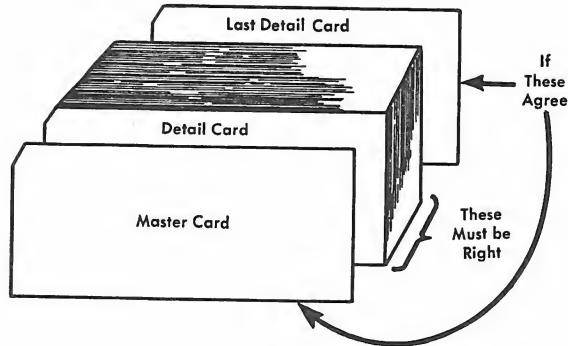
Figure 8. Verifying the gang punch operation

Exercises: Diagram the following exercises on the blank control panel diagrams provided in the back part of this lesson. Compare your solutions with the school solutions which will also be found in the back part of this lesson.

1. a) Gang punch c.c. 1-4
   b) Gang punch c.c. 35-40

2. a) Gang punch c.c. 16-25
   b) Gang punch c.c. 66-72

8.4 Emitting

The IBM 514 Reproducer can manufacture its own impulses if it is equipped with a special device called an emitter. The emitter hubs are located on the left side of the panel. Refer to Figure 9.
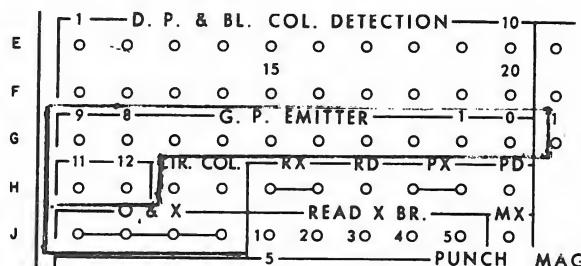
Figure 9. The Emitter hubs on the control panel

The Emitter has 16 hubs. The first twelve emit impulses which correspond to the twelve zones in the card: 12, 11, 9-0. The bottom four hubs labelled O & X emit both the zero impulse and the X impulse. Note that these four hubs are common. This means that all four emit zero and X at the same time.

To cause punching, the emitted impulses are wired directly to the Punch Magnet Entry hubs. The most common applications of the Emitter are to punch control X's, or a standard date, or code numbers in a deck of cards. This could be accomplished by gang punching, but gang punching requires a master card.

You should remember that the first 12 hubs (called the G.P. Emitter) of the emitter are an optional feature in the Reproducer. This means that they will not necessarily be found on every machine. The four hubs (O & X) are standard.

When using the G.P. Emitter, a blank card should precede the deck into the Punch Unit Feed as the G.P. Emitter does not emit impulses until a card has passed the punch brushes. This first card will not be punched.

Problem: Emit the date 123160 in c.c. 75-80. Also emit an "X" to be punched in c.c. 20. See Figure 10 for the correct solution.
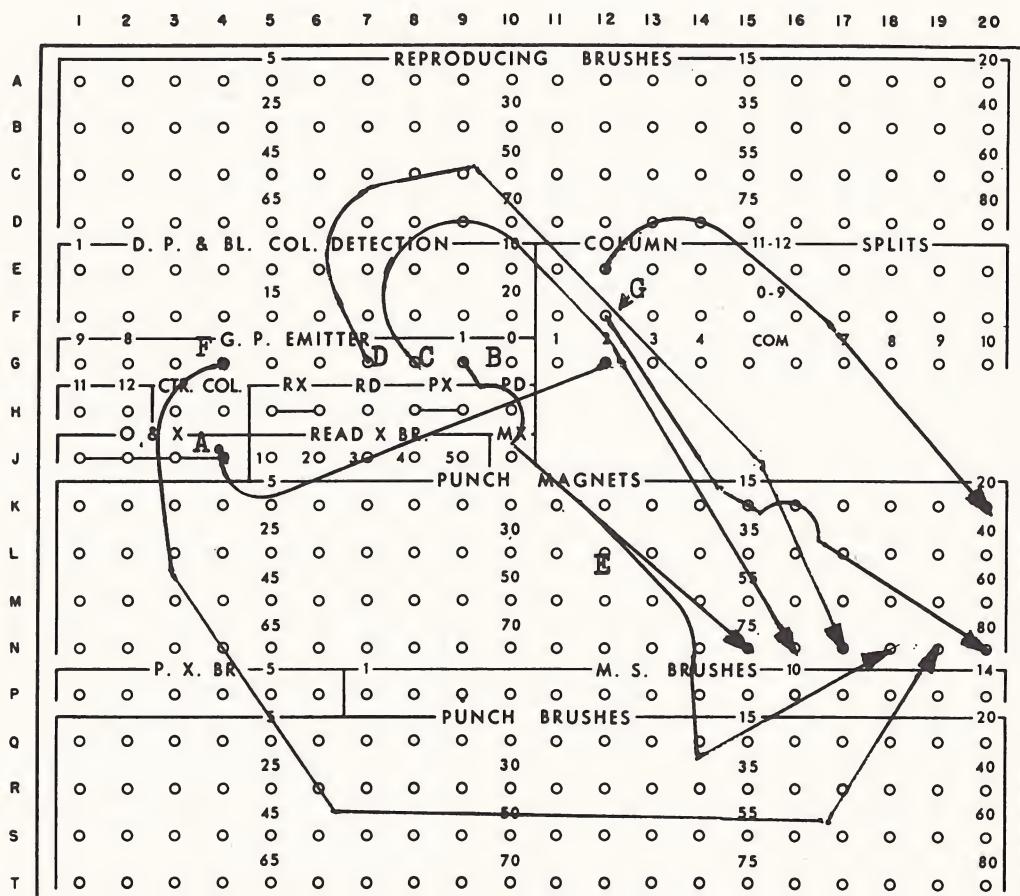
Figure 10. "Emitting" information

Notes on Figure 10:

A. The O & X impulse is wired to the Common hub of a column split. If you recall the lesson on the IBM Interpreter, you will remember the material concerning the X-Eliminator. Well, column splits and X-Eliminators are exactly the same. Remember, that there is an internal connection between the Common and the 0-9 hubs at the time the 0-9 impulses are being read; and a connection between the Common and 11-12 hubs at the time the 11 & 12 impulses are being read. By wiring the O & X impulse to the Common hub of a column split, the O impulse is available from the 0-9 hub and the X impulse is available from the 11-12 hub. In this instance the X impulse is wired to c.c. 20.

B. The digit impulse 1 is wired to c.c. 75.

C. The digit impulse 2 is wired to c.c. 76.

D. The digit impulse 3 is wired to c.c. 77.

E. The digit impulse 1 is split-wired to c.c. 78. Note that there is but one exit hub for each impulse in the G.P. Emitter. Where the same impulse is required in two or more places, we use a technique called split-wiring. Samples of split-wires are illustrated in Figure 11.

F. The digit impulse 6 is wired to c.c. 79.

G. The O portion of the O & X impulse is wired from the 0-9 hub of the column split to c.c. 80. We could have, if we had wanted to, wire the digit impulse O from the G.P. Emitter to c.c. 80.

Exercises: Diagram the following exercises on the blank control panel diagrams provided in the back part of this lesson. Compare your solutions with the school solutions which will also be found in the back part of this lesson.

3. Assume that your Reproducer has a G.P. Emitter installed in it.

    a) Emit the date 042361 in c.c. 1-6

    b) Emit an X punch in c.c. 79

4. Assume that your Reproducer does not have a G.P. Emitter.

    a) Gang punch a date in c.c. 1-6 (using a master card)

    b) Emit an X punch in c.c. 60 and an X punch in c.c. 70.
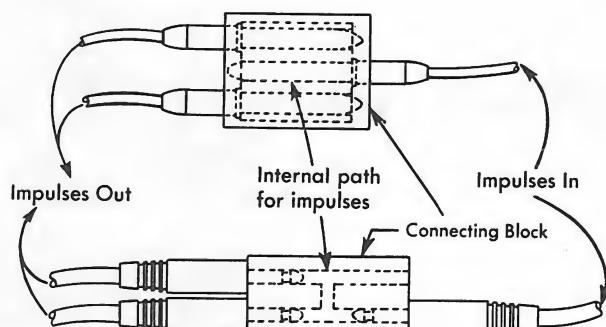
Figure 11. Types of "split-wires."

Closing the rack to position the panel

SUMMARY

In this lesson we have covered one of the basic functions of the IBM 514 Reproducer — gang punching with its associated concept of emitting. Gang punching can be accomplished very simply on the reproducer. You merely create a master card which has in it the data you want to punch in all of your other cards. The master card is placed in front of the detail cards. The control panel is wired from punch brushes (which read the cards) to punch magnets (which punch the cards.) You verify the operation of the machine by sight-checking or comparing the punching in the master card with the punching in the last detail card.

Should the machine you are working with have a G.P. Emitter, you can accomplish the gang punch function without having to create a master card by emitting the information you want. The O & X hubs are standard on every machine and used in conjunction with the column splits, you can punch zeros or X's in selected columns.

Other functions and uses of the Reproducer will be discussed in the following lessons.

GLOSSARY

Column Split — A device which operates exactly like an X-Eliminator. It is used to separate 0-9 from 11 & 12 impulses.

Detail Card — A card which received data from or is controlled by the Master card.

Emitter — A device which manufactures impulses. These impulses are exactly like card punch impulses and can be wired to cause punching.

Functional Switches — These are used to control the operation of the Reproducer. They are all OFF for the gang punch operation.

Gang Punching — Punching information from a Master card into the cards behind it, one at a time.

Joggle Plate — A plastic plate placed on the machine for the convenience of the operator. Cards are placed against this plate and tapped until they are square. This procedure is called joggling.

Master Card — A card which controls the operation of an IBM machine. It usually has some control punch.

Split Wire — A special type of wire that has three ends. It is used when you want to wire the same impulse to more than one place, or to wire several impulses to the same place.

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REPRODUCING BRUSHES

D. P. & BL. COL. DETECTION — COLUMN — SPLITS

0-9

G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10

CTR. COL. — RX — RD — PX — PD

O. & X — READ X BR. — MX

PUNCH MAGNETS

P. X. BR. — M. S. BRUSHES

PUNCH BRUSHES

SELECTOR 1 — SELECTOR 2

SUM. X PCH. CTRL. OR M. S. BRUSHES — 27

COMP. MAG. FROM PUNCH BRUSHES

COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN

COMP. MAG. FROM COMPARING BRUSHES

COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT

COMPARING BRUSHES
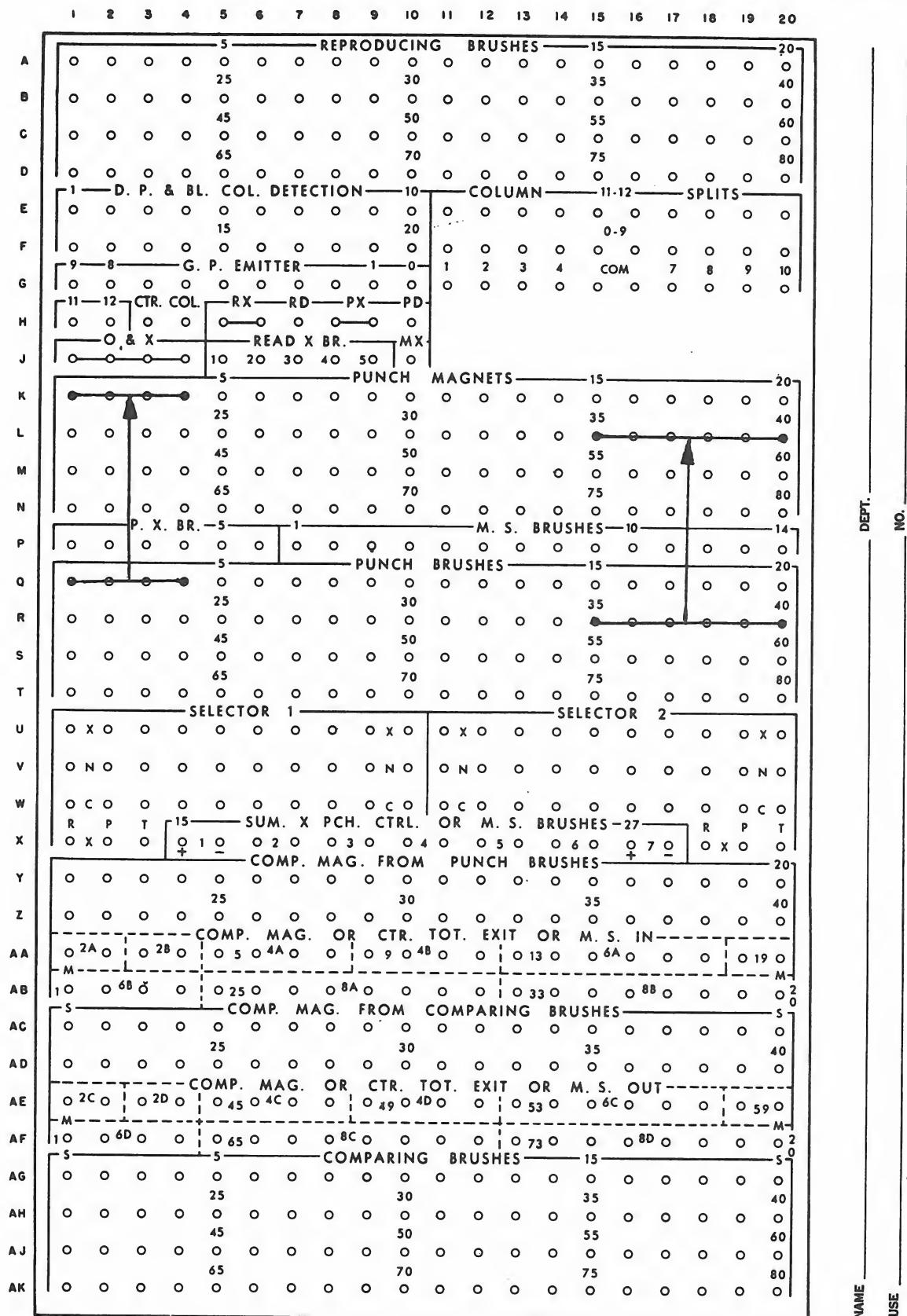
DEPT.   NO.   NAME   USE

Exercise 1 — solution

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

A — 5 — REPRODUCING BRUSHES — 15 — 20
25   30   35   40
B
45   50   55   60
C
65   70   75   80
D

E ┌1 — D. P. & BL. COL. DETECTION — 10 ┐ COLUMN — 11-12 — SPLITS
15   20
F   0-9
G 9 — 8 — G. P. EMITTER — 1 — 0   1 2 3 4 COM 7 8 9 10
H ┌11 — 12 ┐CTR. COL.┌ RX — RD — PX — PD
J ┌ O. & X ┐ — READ X BR. ┐MX
10 20 30 40 50

K — 5 — PUNCH MAGNETS — 15 — 20
25   30   35   40
L
45   50   55   60
M
65   70   75   80
N
P — P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14
Q — 5 — PUNCH BRUSHES — 15 — 20
25   30   35   40
R
45   50   55   60
S
65   70   75   80
T

U — SELECTOR 1 — — SELECTOR 2 —
O X O   O X O   O X O   O X O
V
O N O   O N O   O N O   O N O
W
O C O   O C O   O C O   O C O
R P T — 15 — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T
X O X O   O 1 O O 2 O O 3 O O 4 O O 5 O O 6 O O 7 O O X O
+ —   COMP. MAG. FROM PUNCH BRUSHES — 20   + —
Y
25   30   35   40
Z
— COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN —
AA O 2A O O 2B O O 5 O 4A O O O 9 O 4B O O O 13 O O 6A O O O 19 O
M —   M
AB 1 O O 6B O O O 25 O O O 8A O O O O 33 O O O 8B O O O 2/0
S —   COMP. MAG. FROM COMPARING BRUSHES —   S
AC
25   30   35   40
AD
— COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT —
AE O 2C O O 2D O O 45 O 4C O O O 49 O 4D O O O 53 O O 6C O O O 59 O
M —   M
AF 1 O O 6D O O O 65 O O O 8C O O O O 73 O O O 8D O O O 2/0
S — 5 — COMPARING BRUSHES — 15 —   S
AG
25   30   35   40
AH
45   50   55   60
AJ
65   70   75   80
AK

DEPT.   NO.

NAME   USE

Exercise 2 — solution

Exercise 3 — solution

Notes on Solution to Exercise 3:

The X can be emitted in c.c. 79 using the 11 hub of the G.P. Emitter or by wiring the O & X impulse through a column split. Either method would be correct. Also, the zero wired to c.c. 1 could come from the G.P. Emitter or from the O & X impulse wired through a column split.
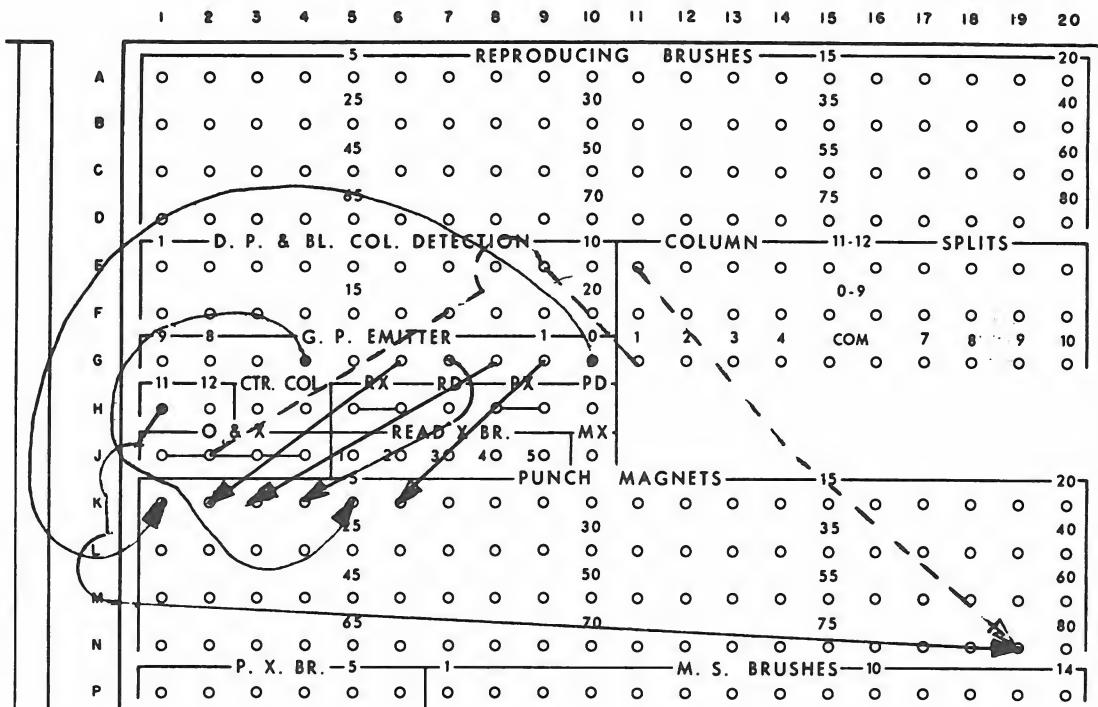
Exercise 4 — solution

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Control panel wiring chart. Row labels A–AK; column numbers 1–20. Section labels include:
REPRODUCING BRUSHES; D. P. & BL. COL. DETECTION — COLUMN — 11-12 — SPLITS; G. P. EMITTER; CTR. COL. — RX — RD — PX — PD; O & X — READ X BR. — MX; PUNCH MAGNETS; P. X. BR. — M. S. BRUSHES; PUNCH BRUSHES; SELECTOR 1 — SELECTOR 2; SUM. X PCH. CTRL. OR M. S. BRUSHES; COMP. MAG. FROM PUNCH BRUSHES; COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN; COMP. MAG. FROM COMPARING BRUSHES; COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT; COMPARING BRUSHES.

Left side panel: NOTES; CARD NAME OR FUNCTION; ELECTRO NO.; X OR DIGIT; BLANK COLUMN CHECK SWITCHES (1-10, OFF/ON); REPRODUCE; SEL REPD AND GP COMP; CARD X PUNCHED; MARK SENSING; MASTER CARD PUNCHING; SWITCHES (ON/OFF rows).

Right side: DEPT.; NO.; NAME; USE.

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Control panel wiring diagram with rows A through AK and columns 1 through 20, including sections: REPRODUCING BRUSHES, D. P. & BL. COL. DETECTION, COLUMN SPLITS, G. P. EMITTER, CTR. COL., O & X, READ X BR., PUNCH MAGNETS, P. X. BR., M. S. BRUSHES, PUNCH BRUSHES, SELECTOR 1, SELECTOR 2, SUM. X PCH. CTRL. OR M. S. BRUSHES, COMP. MAG. FROM PUNCH BRUSHES, COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN, COMP. MAG. FROM COMPARING BRUSHES, COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT, COMPARING BRUSHES.

IBM

Control panel wiring chart with columns numbered 1–20 and rows A through AK. Labeled sections include:

- REPRODUCING BRUSHES (rows A–D)
- D. P. & BL. COL. DETECTION — COLUMN — SPLITS (rows E–F)
- G. P. EMITTER (row G)
- CTR. COL. — RX — RD — PX — PD (row H)
- O. & X — READ X BR. — MX (row J)
- PUNCH MAGNETS (rows K–N)
- P. X. BR. — M. S. BRUSHES (row P)
- PUNCH BRUSHES (rows Q–T)
- SELECTOR 1 — SELECTOR 2 (rows U–X)
- SUM. X PCH. CTRL. OR M. S. BRUSHES (row X)
- COMP. MAG. FROM PUNCH BRUSHES (rows Y–Z)
- COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN (rows AA–AB)
- COMP. MAG. FROM COMPARING BRUSHES (rows AC–AD)
- COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT (rows AE–AF)
- COMPARING BRUSHES (rows AG–AK)

Left side form fields: ELECTRO NO., CARD NAME OR FUNCTION, NOTES, X OR DIGIT, BLANK COLUMN CHECK SWITCHES (OFF/ON), REPRODUCE, SEL REPD AND GP COMP, CARD X PUNCHED, MARK SENSING, MASTER CARD PUNCHING, SWITCHES (ON/OFF, MSTR/DET).

Right side: DEPT., NO., NAME, USE.

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FOR SUMMARY PUNCHING—ALPHABETIC ACCOUNTING MACHINE

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Control panel diagram with columns numbered 1–20 and rows A through AK:

- A–D: 5 —— REPRODUCING BRUSHES —— 15 —— 20 (25 30 35 40 / 45 50 55 60 / 65 70 75 80)
- E: 1 — D. P. & BL. COL. DETECTION —— 10 —— COLUMN —— 11-12 —— SPLITS
- F: 15 / 20 / 0-9
- G: 9 — 8 —— G. P. EMITTER —— 1 — 0 / 1 2 3 4 COM 7 8 9 10
- H: 11 — 12 — CTR. COL. — RX — RD — PX — PD —
- J: O & X —— READ X BR. —— MX / 10 20 30 40 50
- K–N: 5 —— PUNCH MAGNETS —— 15 —— 20 (25 30 35 40 / 45 50 55 60 / 65 70 75 80)
- P: P. X. BR. — 5 — 1 —— M. S. BRUSHES — 10 —— 14
- Q–T: 5 —— PUNCH BRUSHES —— 15 —— 20 (25 30 35 40 / 45 50 55 60 / 65 70 75 80)
- U: SELECTOR 1 / SELECTOR 2 (X)
- V: (N)
- W: (C)
- X: R P T — 15 —— SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 —— R P T (1 / 2 3 4 5 6 7) + —
- Y–Z: COMP. MAG. FROM PUNCH BRUSHES —— 20 (25 30 35 40)
- AA: COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN (2A 2B 5 4A 9 4B 13 6A 19) M
- AB: 10 6B 25 8A 33 8B 20 S
- AC–AD: COMP. MAG. FROM COMPARING BRUSHES (25 30 35 40)
- AE: COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT (2C 2D 45 4C 49 4D 53 6C 59) M
- AF: 10 6D 65 8C 73 8D 20 S
- AG–AK: 5 —— COMPARING BRUSHES —— 15 —— S (25 30 35 40 / 45 50 55 60 / 65 70 75 80)

Left side form fields:

NOTES

CARD NAME OR FUNCTION

X OR DIGIT

BLANK COLUMN CHECK SWITCHES — 1 2 3 4 5 6 7 8 9 10 — OFF / ON

ELECTRO NO.

REPRODUCE — SEL REPD AND GP COMP — CARD X PUNCHED — MARK SENSING — MASTER CARD PUNCHING

SWITCHES:
OFF / OFF / MSTR / OFF / OFF
ON / ON / DET / ON / ON

DEPT.
NO.
NAME
USE

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FOR SUMMARY PUNCHING—ALPHABETIC ACCOUNTING MACHINE

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Control panel diagram with rows labeled A through AK and columns 1 through 20.

- A–D: REPRODUCING BRUSHES (5 ... 15 ... 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- E: D. P. & BL. COL. DETECTION — COLUMN — 11-12 — SPLITS
- F: 0-9
- G: G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10
- H: 11 12 CTR. COL. RX RD PX PD
- J: O & X — READ X BR. — MX — 10 20 30 40 50
- K–N: PUNCH MAGNETS (5 ... 15 ... 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- P: P. X. BR. 5 — 1 — M. S. BRUSHES 10 — 14
- Q–T: PUNCH BRUSHES (5 ... 15 ... 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- U–W: SELECTOR 1 — SELECTOR 2
- X: SUM. X PCH. CTRL. OR M. S. BRUSHES — 15 ... 27, RPT, RPT
- Y–Z: COMP. MAG. FROM PUNCH BRUSHES (25, 30, 35, 40)
- AA–AB: COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN
- AC–AD: COMP. MAG. FROM COMPARING BRUSHES (25, 30, 35, 40)
- AE–AF: COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT
- AG–AK: COMPARING BRUSHES (5 ... 15 ... 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)

NOTES

DEPT.

NO.

NAME

USE

Side panel (left)

ELECTRO NO.

CARD NAME OR FUNCTION

X OR DIGIT

BLANK COLUMN CHECK SWITCHES — OFF / ON — 1 2 3 4 5 6 7 8 9 10

REPRODUCE	OFF	ON
SEL REPD AND GP COMP	OFF	ON
CARD X PUNCHED	MSTR	DET
MARK SENSING	OFF	ON
MASTER CARD PUNCHING	OFF	ON

SWITCHES

EXAMINATION

INSTRUCTIONS: Your examinations are important to you as they indicate how well you understand the lesson material. Be sure to allow yourself enough time to complete the examination. Read each question carefully and be sure you understand it. Mark your answers in the proper box. Review the exam to be sure that all questions have been answered.

1. Which one of the following functions cannot be performed by the Reproducer —

   a) Punch information into cards
   b) Print on the face of the card
   c) Emit impulses
   d) Gang punch a deck of cards

2. The operating speed of the Reproducer is

   a) 60 cards per minute
   b) 650 cards per minute
   c) 100 cards per minute
   d) depends on the job being done

3. The actual punching of the card in the Reproducer is done at —

   a) the joggle plate
   b) the punching dies
   c) the punch brushes
   d) the emitter

4. To accomplish gang punching we wire from

   a) punch magnets to punch brushes
   b) G.P. Emitter to punch brushes
   c) punch brushes to punch magnets
   d) all the above are incorrect

5. Which of the following statements is False

   a) The O & X hubs are standard
   b) The O & X hubs are common
   c) The G.P. Emitter is standard
   d) Column splits are standard

6. Which of the following statements is False

   a) In gang punching, the master card is placed in front of the detail cards.
   b) When emitting information from the G.P. Emitter, a blank card is placed in front of the detail cards.
   c) The functional switches are ON for gang punching.
   d) It is not necessary to use a master card when emitting data from the G.P. Emitter.

Answer the following questions True or False. If True, mark an X in answer Box A; if False, mark an X in answer Box B.

7. A method of checking the gang punch operation is called sight checking.

8. Should you wire the O & X impulse into the Common hub of a column split, the O impulse would be available from the 11-12 hub.

9. It is possible to split wire an impulse to be punched in more than one column of a card.

10. The Reproducer reads information from cards at the Punch Brushes and transmits the information read back to the punching dies.

11. There are 60 punching dies in the Reproducer.

12. There are 80 reproducing brushes in the Reproducer.

13. Cards do not have to be joggled before being placed in the Reproducer.

14. Cards feed into the Reproducer face down, 9 edge in.

Refer to Figure 12 and answer the following questions True or False.

15. The diagram is wired to gang punch c.c. 66-70.

16. An "X" will be punched in c.c. 80.

17. An "X" will be emitted in c.c. 21.

18. Assume that the master card has the letter R (an X punch and a 9 punch) in c.c. 15. All the detail cards will have the letter R gang punched in them.

19. Assume that the master card has the letter P (an X punch and a 7 punch) in c.c. 15. All the detail cards will have the digit 7 punched in them.

20. The letter R will be emitted in c.c. 60.
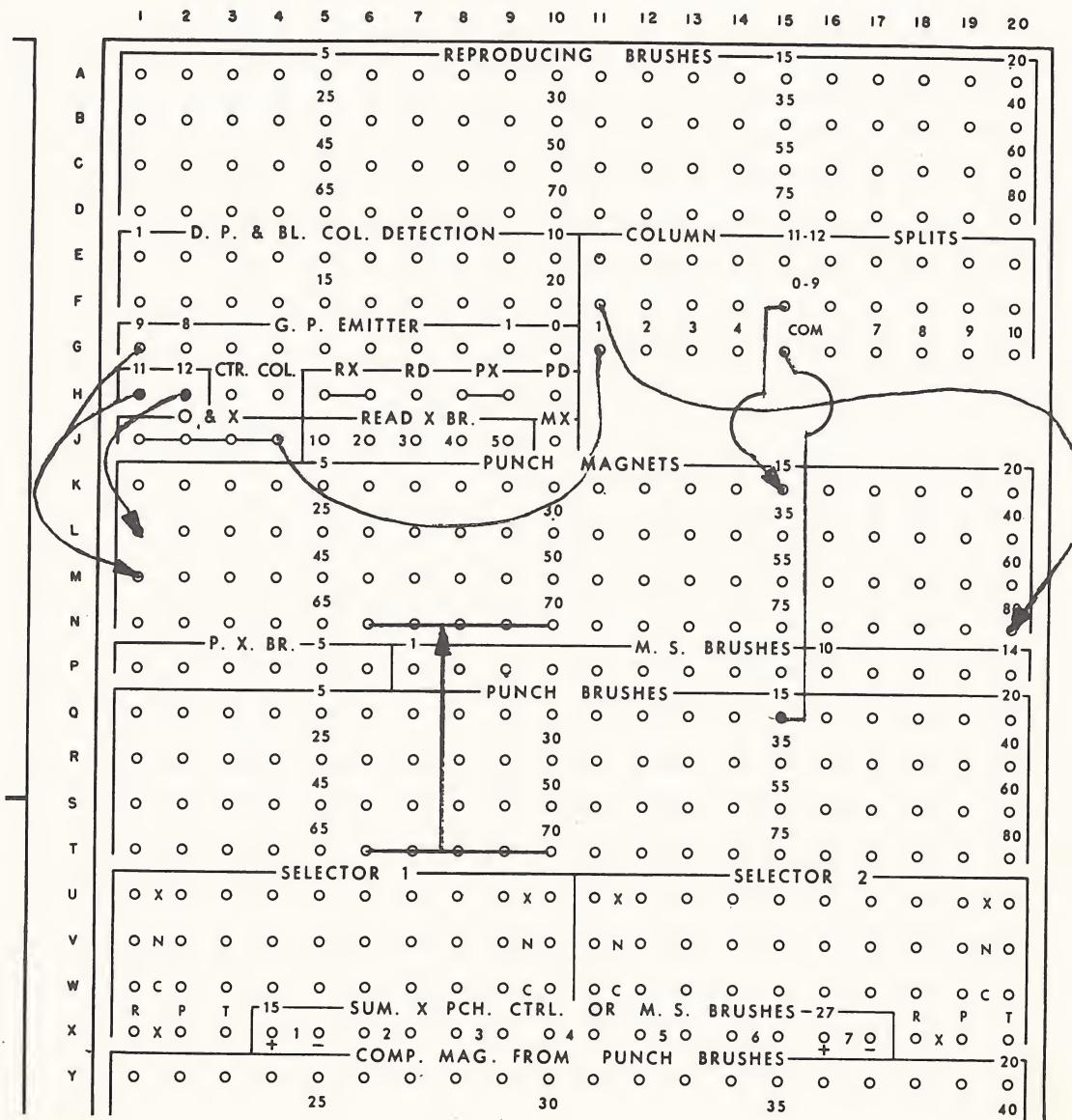
Figure 12.

I.B.M. DATA PROCESSING
AND COMPUTER PROGRAMMING

LESSON No. 9

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PREFACE

In the next two lessons we are going to complete our study of the IBM 514 Reproducer. We are going to discuss two basic reproducer operations: reproducing (with comparing) and interspersed gang punching. We will have an opportunity to again see how gang punching and emitting are accomplished.

The reproducer is a very powerful tool in the IBM Data Processing installation. It permits us to create, change and add information to IBM cards at a very high rate of speed. In addition, as you will see, there is a means provided whereby we can check our work to see if it is being accomplished accurately.
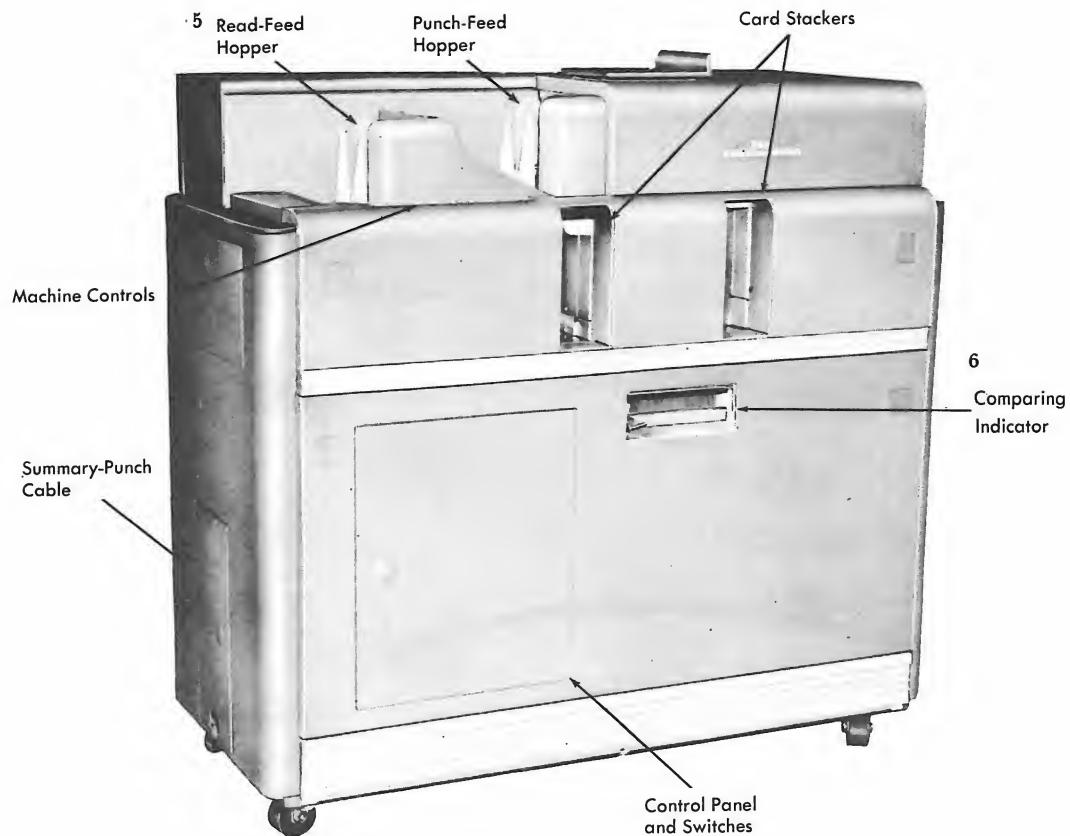
Figure 1. The IBM 514 Reproducer

9.1 Reproducing

Reproducing is a technique whereby we are able to duplicate varied information from one card into another card. The reproducing operation always involves two decks of cards: the original group which has been punched, and a second group of blank (or partially blank) cards that are to be punched with information from the original cards. In essence, what we are going to do is to read information from one deck of cards and punch this information into a second deck of cards. At the same time we are going to check the operation of the machine to see that it is performing its work properly.

Refer to Figure 1 for a description of the operating characteristics of the Reproducer which have not as yet been discussed but are used in the reproducing operation.

5. *Read-Feed Hopper* — there are two hoppers in the Reproducer. The Punch-Feed hopper was discussed in lesson 8. This is the hopper used in the standard gang-punch operation. For reproducing, the original deck is placed in the Read-Feed Hopper and the second deck (the one we are going to punch into) is placed in the Punch Feed Hopper. Information is read from the cards which are fed from the Read-Feed Hopper and transmitted to be punched into cards being fed
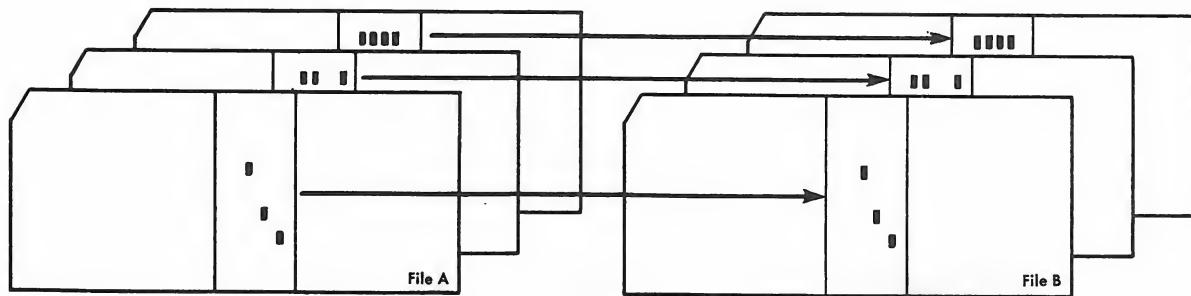
Figure 2. Example of the Reproducing Function
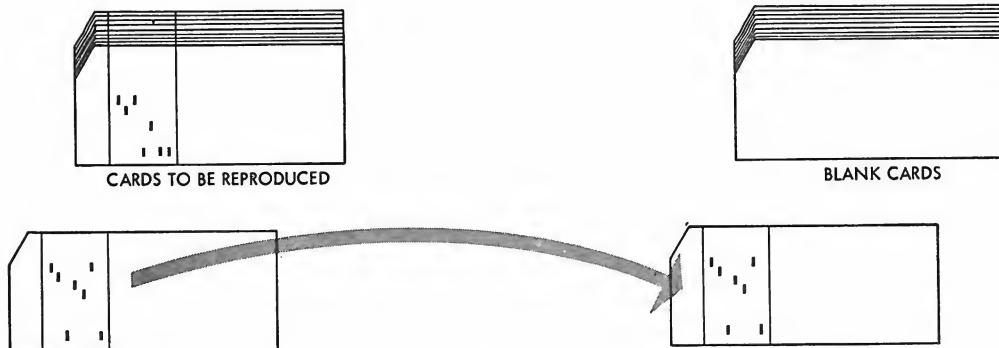
Figure 2a. Reproducing from Original Cards Into Blanks
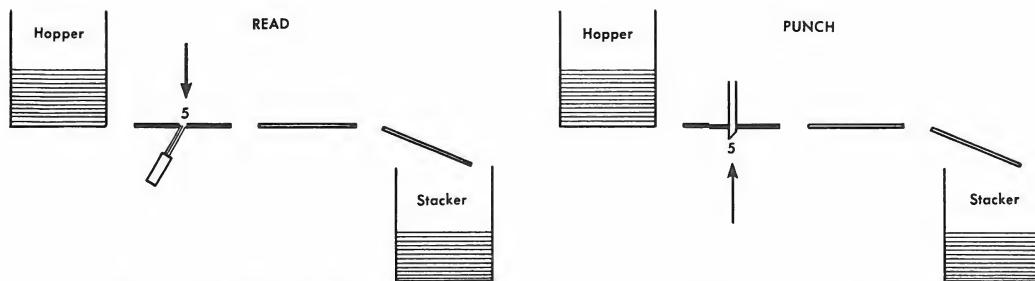
Figure 3. What is Read at the Reproducing Brushes is Punched at the Punching Dies

from the Punch-Feed Hopper. Figures 2, 2a & 3 illustrate a reproducing operation. File A would be placed in the Read-Feed Hopper. File B would be placed in the Punch Feed Hopper. The information read from File A would be punched into the cards of file B. How the machine accomplishes this will be described in the next section of this lesson.

6. *Comparing Indicator* — at the same time the machine is reproducing information from one deck of cards into another, it is also checking its work. After information from File A is reproduced into File B the machine "compares" both File A and File B to see if they are equal. Should they not be equal, this would be indicated on the Comparing Indicator. A close-up view of the Comparing Indicator is contained in Figure 4. A more detailed review of the function of the Comparing Indicator will be contained in the next section of this lesson.
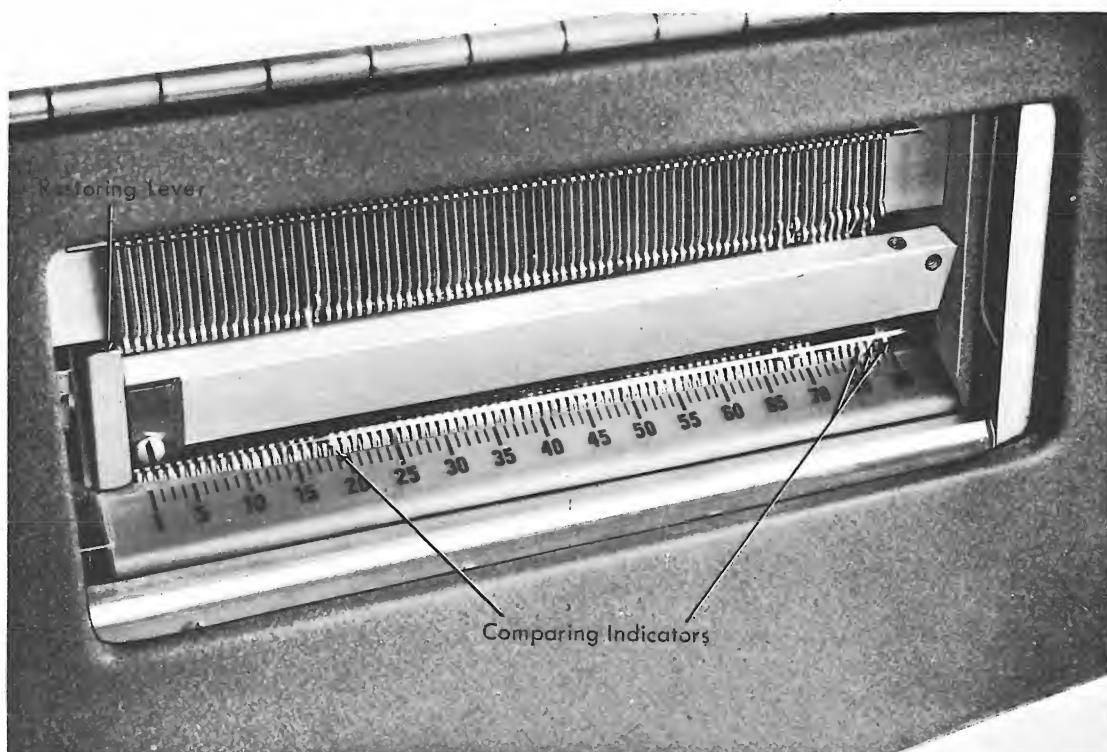
Figure 4. The Comparing Indicator

9.2 Schematic of the Reproducing Function

The IBM 514 Reproducer consists of two sections: (1) The Punching Unit at which all punching takes place. We have already examined the use of the punching unit in our lesson on gang-punching and emitting. Information is read from cards which are placed in the Punch-Feed Hopper. The reading is accomplished at 80 brushes called the Punch Brushes. Punching takes place at the 80 punching dies called the Punch Magnets; (2) the second section of the Reproducer is called the Reading Unit. This unit is used in combination with the Punching Unit to perform the operation called Reproducing.

Since we are going to use two feed units in the reproducing operation, we must have some means of causing both units to feed at the same time (they must be synchronized.) Figure 5 contains a close-up view of the functional switches. The functional switches were also discussed in lesson 8. They are located in the control panel section. For gang-punching, they are all in the OFF position, meaning they are up. Refer to Figure 5A. For the reproducing function the master switch at the left (marked "reproduce") is in the ON position, meaning it is pushed down. With the reproduce switch in the ON position, feeding from both feeds is synchronized.
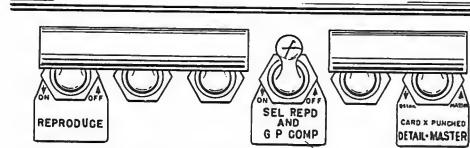
Figure 5. The Functional Switches

Let us examine in detail the schematic of the Reading and Punching unit as they appear in Figure 6. Look at the Punching Unit first as we are familiar with some of its elements.

1. The deck to be punched is placed in the Punch-Feed hopper. Immediately to the right of the Punch-Feed hopper, you will see the 6 punch x-brushes. These brushes are not used in reproducing so for the moment let us ignore them. They are used in interspersed gang punching and they will be discussed when that topic is being studied.
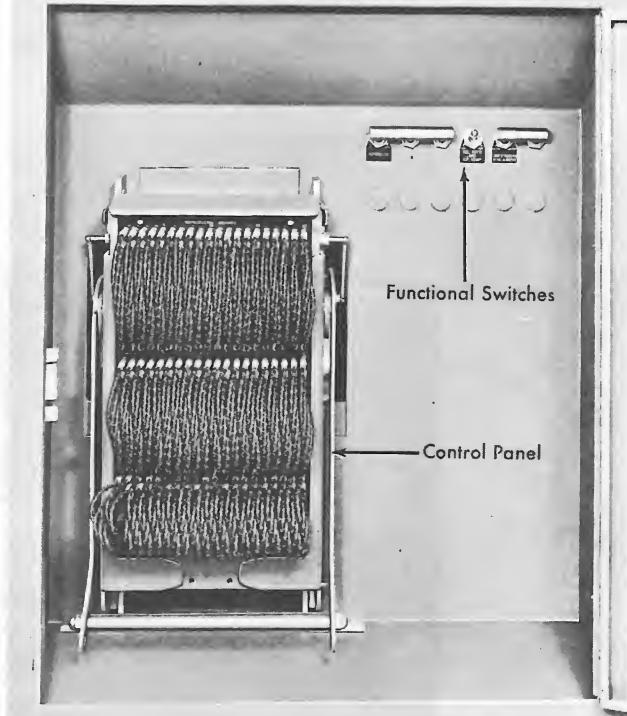
Figure 5a. Functional Switches and Control Panel
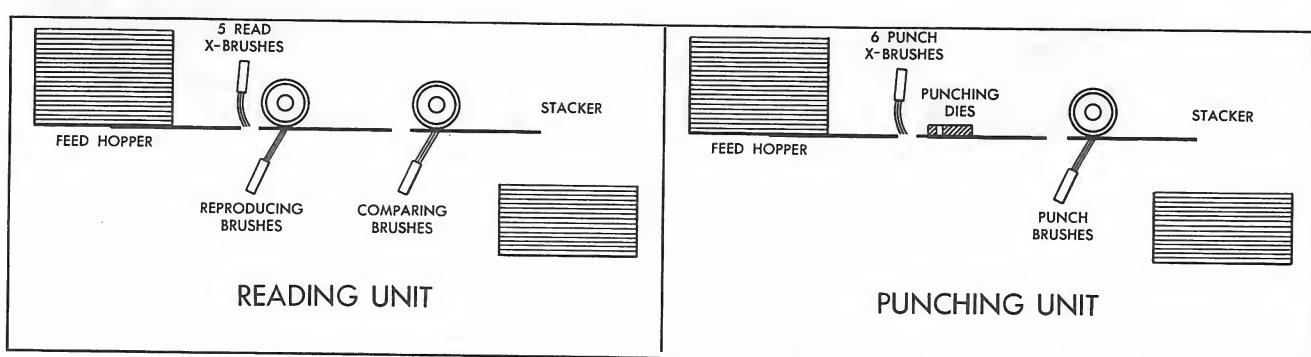
Figure 6. Read and Punch Unit Stations

2. The next element to be considered is the punching dies. We know from our gang punch lesson that all punching which takes place in the reproducer will take place at this station.

3. The next element in the Punching unit is the Punch Brush station. For the gang punch function, information is read from cards at the Punch Brush station and transmitted back to the Punching dies to be punched. For reproducing however, the Punching Brushes serve an entirely different function. We will discuss this soon.

4. The last element in the Punching Unit is the stacker which houses the cards after they have been processed.

Let us now look at the elements present in the Reading Unit.

1. Our original deck is placed in the Read-Feed hopper. Immediately to its right you will see 5 read x-brushes. Again, the read x-brushes, like the punch x-brushes are not part of our reproducing function. For the time being, ignore them.

2. To the right of the read x-brushes you will see a station called the Reproducing Brushes. Here we have 80 brushes exactly like the Punch Brushes. To accomplish reproducing, information is read from a card by the Reproducing brushes and transmitted to the Punching dies to be punched into the card passing under the punching dies.

3. The next element in the Reading Unit is called the Comparing Brush station. After a card has passed the Reproducing brushes, it passes under the 80 Comparing brushes. At this time, since cards are being fed in both feeds in synchronization, the card which was punched into will be read by the Punch brushes. The information being read by the Comparing brushes will be "compared" within the machine with the information being read by the Punching brushes. It should be identical. If it is not, the machine will stop, and the comparing indicator will tell us where the error is.

4. The last element in the Reading Unit is the stacker which houses the cards after they have been processed.

Let us use an example to review the reproducing function. Assume that we have a card which is punched "ABCD" in c.c. 1-4. We wish to take this information and reproduce it into a blank card in the same card columns.

a. The card which is already punched is placed in the Read-Feed hopper.

b. The blank card is placed in the Punch-Feed hopper.

c. The control panel is wired and placed in the control panel rack.

d. The functional switch marked "reproduce" is turned ON (down).

e. The start button is pressed. On the first machine cycle, the card from the Read-Feed hopper passes under the read x-brushes, and the card from the Punch-Feed hopper passes under the punch x-brushes. Nothing will happen as these brushes play no part in reproducing.

f. On the next machine cycle, the card on the read side of the machine will pass under the Reproducing brushes. At the same time the card on the punch side of the machine will pass under the Punching dies. The information being read by the Reproducing brushes will be transmitted to the Punching dies and punched into the card passing under them.

g. On the next machine cycle, the card on the read side of the machine will pass under the Comparing brushes and the information in the card will be read and sent to the comparing unit. At the same time, the card on the punch side of the machine will be passing under the Punching brushes. It will be read there and the information being read will also be sent to the comparing unit. The comparing unit will compare the information sent to it by the Comparing brushes with the information sent to it by the Punching brushes. If the information is identical, the machine will continue to run. If there is a discrepancy, the machine will stop and the comparing indicator will indicate where the discrepancy is.

Figure 7 illustrates the schematic of the reproducing function also. Note that the read x-brushes and the punch x-brushes have been removed from the diagram merely to simplify it.
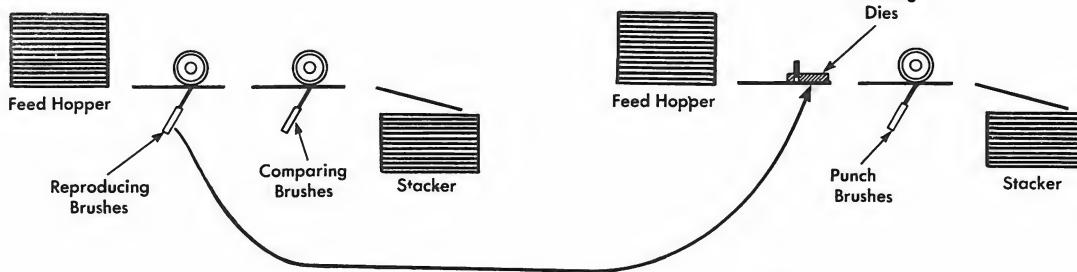
Figure 7. Schematic of Reproducing Function

Let us examine Figure 8 which is the control panel diagram for reproducing c.c. 1-4 into c.c. 1-4.

We will study the nature of comparison in IBM equipment.
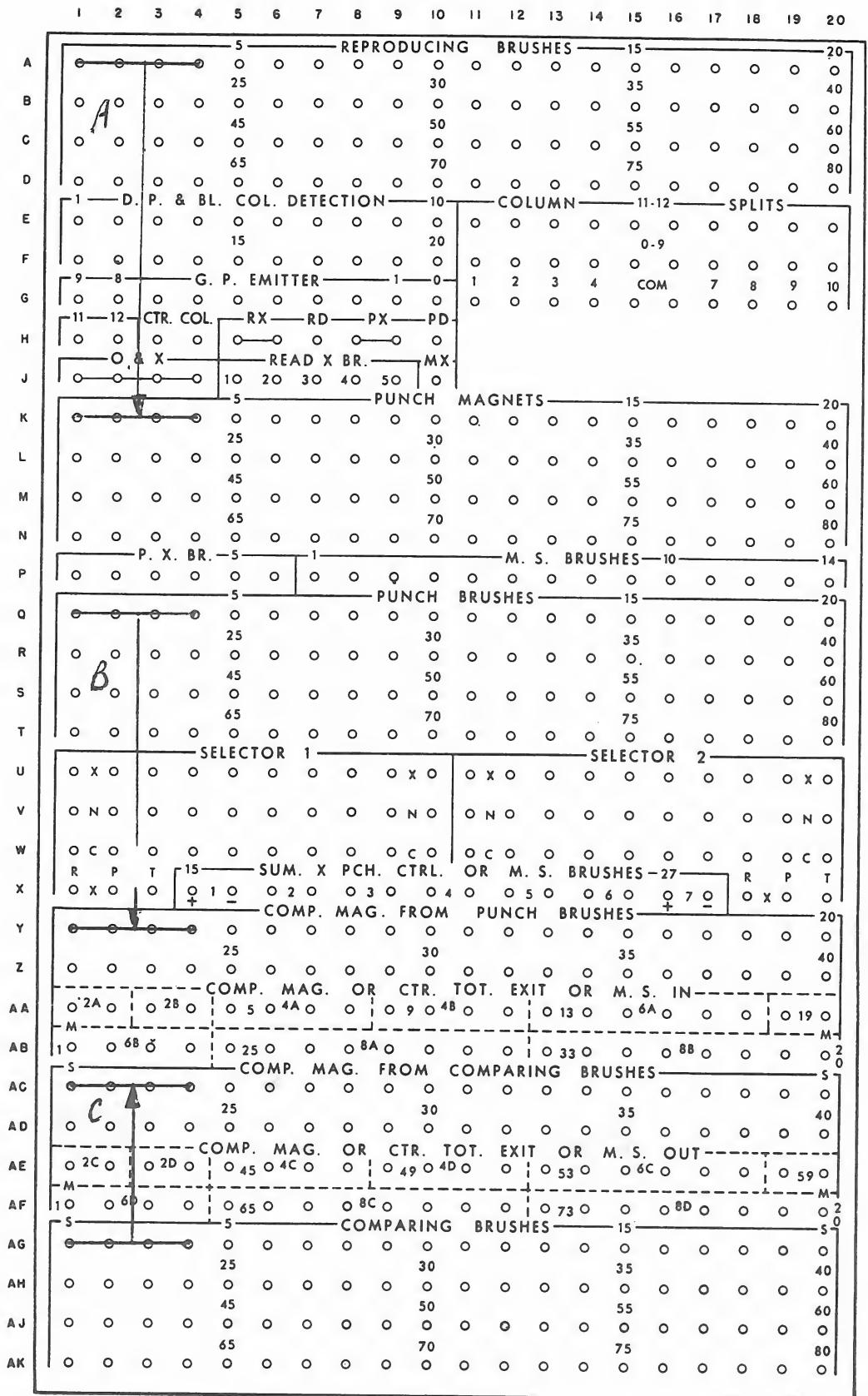
Figure 8.

Notes on Figure 8.

A. The 80 reproducer brush exit hubs are to be found on the diagram at A-D, 1-20. They are wired directly to the Punch Magnets to cause punching.

B. The impulses from the Punch Brushes are wired to the hubs labelled, "Comparing Magnets from Punch Brushes." There may be 80 comparing magnets in the Reproducer or 45. The first 45 are standard; the last 35 (#46-80) are optional.

C. The impulses from the Comparing Brushes are wired to the hubs labelled, "Comparing Magnets from Comparing Brushes." Should there be a disagreement in the information being sent to the Comparing Magnets from the Punch Brushes and the information sent to the Comparing Magnets from the Comparing Brushes, the Reproducer will stop. When we discuss the nature of comparison, we will show you how the comparing unit indicates where the error is.

9.3 Comparing in IBM Equipment

Comparing in IBM equipment is accomplished by comparing magnets. For each position of comparison, there are two magnets. Between the magnets, there is an armature. Information being read from cards is sent to the comparing magnet. See Figure 9.

These magnets can be in one of four possible conditions at any time. See Figure 10. In the upper
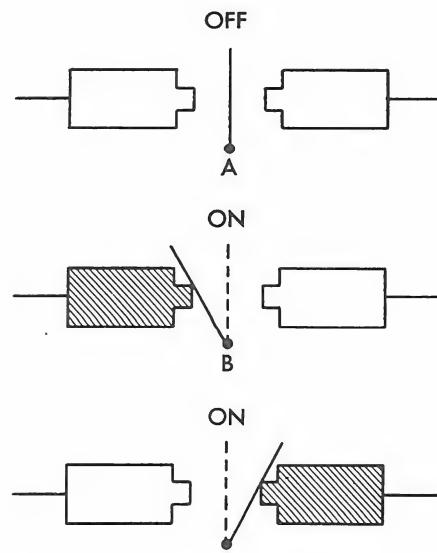
Figure 10. Possible Comparing Magnet Conditions

diagram of Figure 10, neither of the two magnets for this comparing position has received an impulse. Both magnets are de-energized, the armature is not attracted to either of them, and this is a normal or valid comparison.

Figure 9. Comparing Schematic

In the middle diagram the left hand magnet is energized, but not the right hand magnet. The armature is attracted to the left hand magnet, completes the circuit and the machine will stop.

In the lower diagram the right hand magnet is energized, but not the left hand magnet, The armature is attracted to the right hand magnet, completes the circuit and the machine will stop.

Figure 11 and 12 illustrate two unequal conditions.
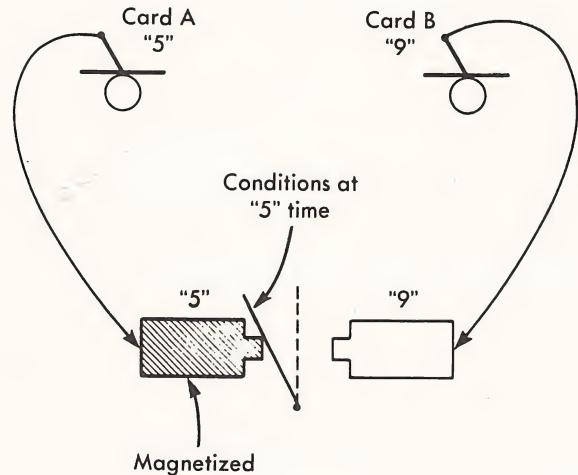
Figure 11. An Unequal Condition
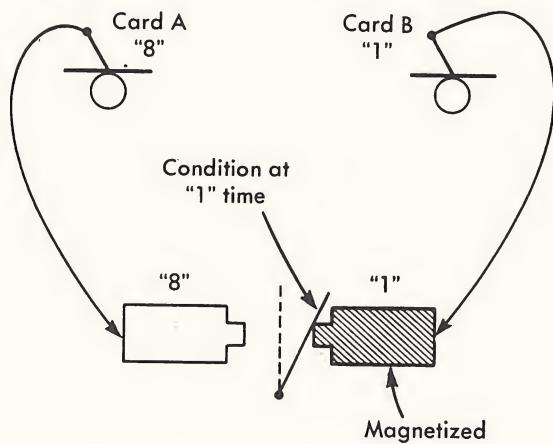
Figure 12. An Unequal Condition

Figure 13 illustrates the fourth possibility, where the information entering both magnets of the same comparing position is identical. Both magnets would be energized at exactly the same time. The armature remains in the center. It would not complete a circuit with either the right hand or left hand magnet and the Reproducer would continue to run.

When the machine recognizes an unequal condition (when the armature on any comparing magnet is attracted and completes a circuit) three things happen:
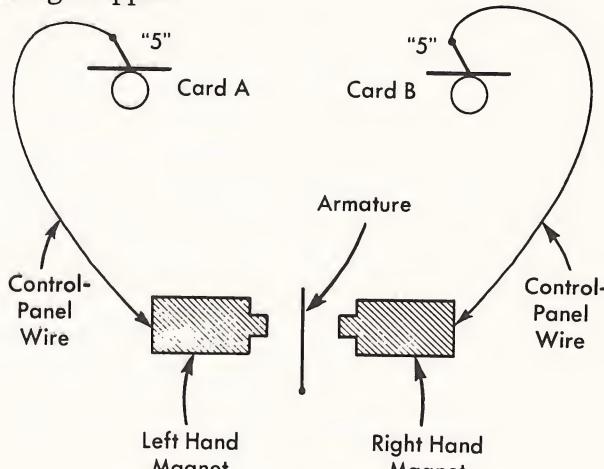
Figure 13. An Equal Condition

1. The machine stops at the end of that machine cycle.

2. A signal light goes on to tell the operator that the machine has stopped because of an unequal condition.

3. Mechanical fingers are raised to indicate to the operator which comparing magnets are unequal.
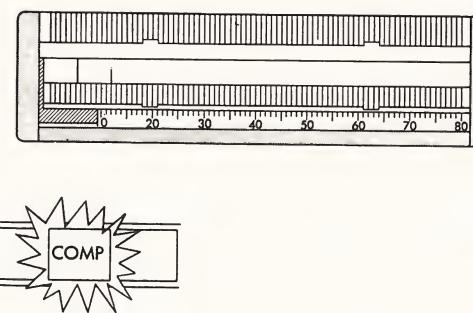
Figure 14. Comparing Error Indication

The operator then examines his control panel to see which card columns are wired to the magnets which are unequal. Once he locates the card columns, he can inspect his cards and correct the error. He then restores the comparing unit using the Restoring Lever (found on left side of unit) and re-starts the machine.

An error in reproducing can occur because:

1. The machine fails to punch what it is reading.

2. The cards being punched into had punches in them before the reproducing took place. By reproducing information into a column which has a punch in it we get as a result a card with more than one character in the same card column. For example, when we punched ABCD which was in c.c. 1-4 into another card we assumed that the second card was blank in c.c. 1-4. If instead of being blank, the second card had a 9 in c.c. 4, after it was punched it would have a 12 punch, a 4 punch and a 9 punch in c.c. 4. This would be compared with the original card which had a 12 punch and a 4 punch in c.c. 4 (the letter D) and the result would be unequal and the machine would stop and indicate that comparing magnet 4 was in error.

Let us develop a few problems to illustrate typical reproducing applications:

1. Our original deck of cards has employee number in c.c. 1-4, and social security number in 24-32. We are to reproduce employee number into c.c. 9-12 and social security number into c.c. 50-58. This application is called "offset reproducing." Also, the new cards are to have an X punch in c.c. 79.

2. a) Reproduce c.c. 16-20 from the original deck into c.c. 14-18 of the new deck.

   b) Reproduce c.c. 65-72 from the original deck into c.c. 44-51 of the new deck.

   c) Assume that you have a G.P. Emitter in the machine. Emit the date May 18 (0518) in c.c. 1-4.

3. a) Reproduce c.c. 38-47 into c.c. 21-30.

   b) Reproduce c.c. 10-15 into c.c. 10-15.

   c) The machine has no G.P. Emitter. Gang-punch the date 0518 into c.c. 77-80 using a master card.

School solutions to these problems along with explanatory notes will be found on the next few pages.
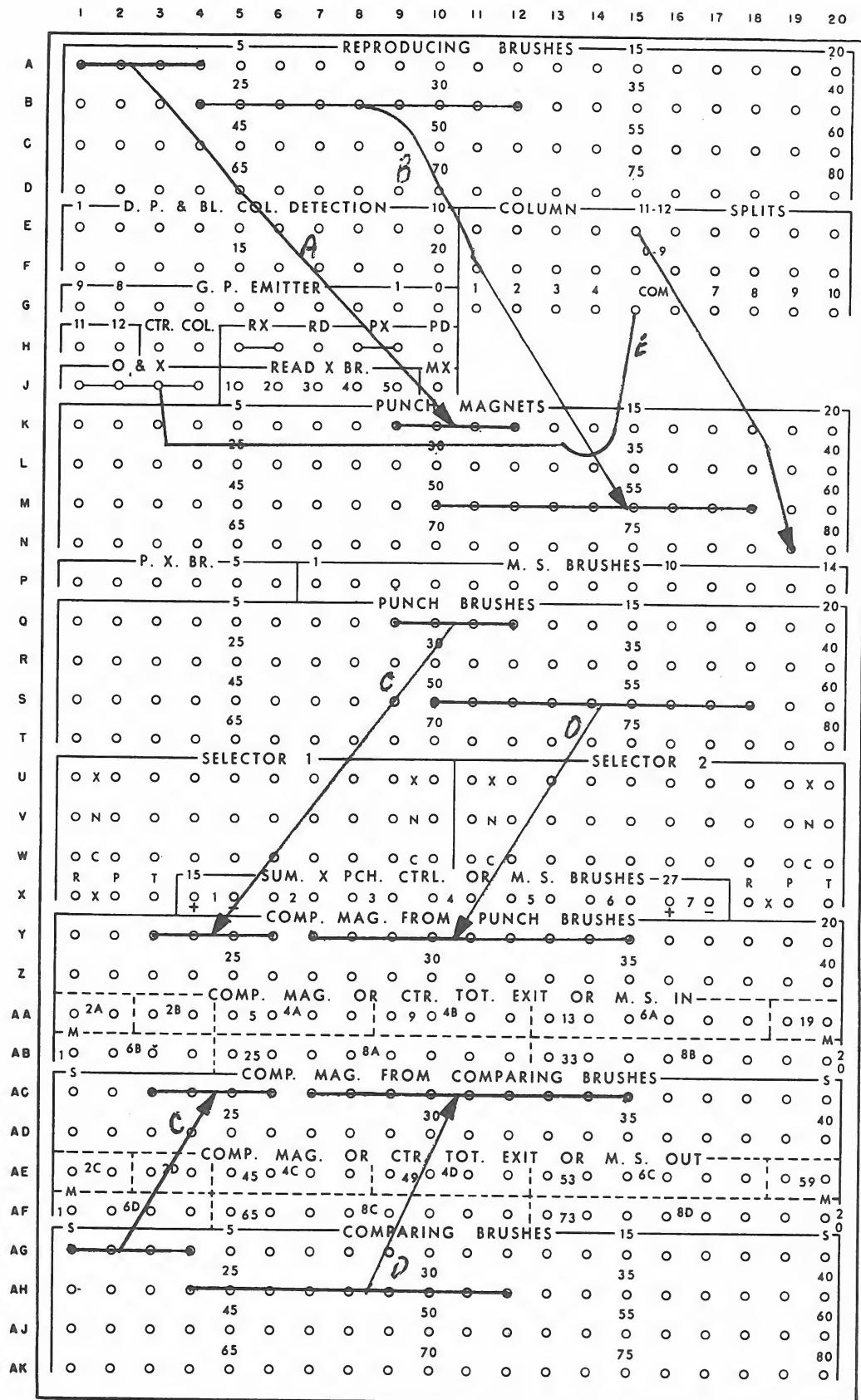
Solution to Problem 1
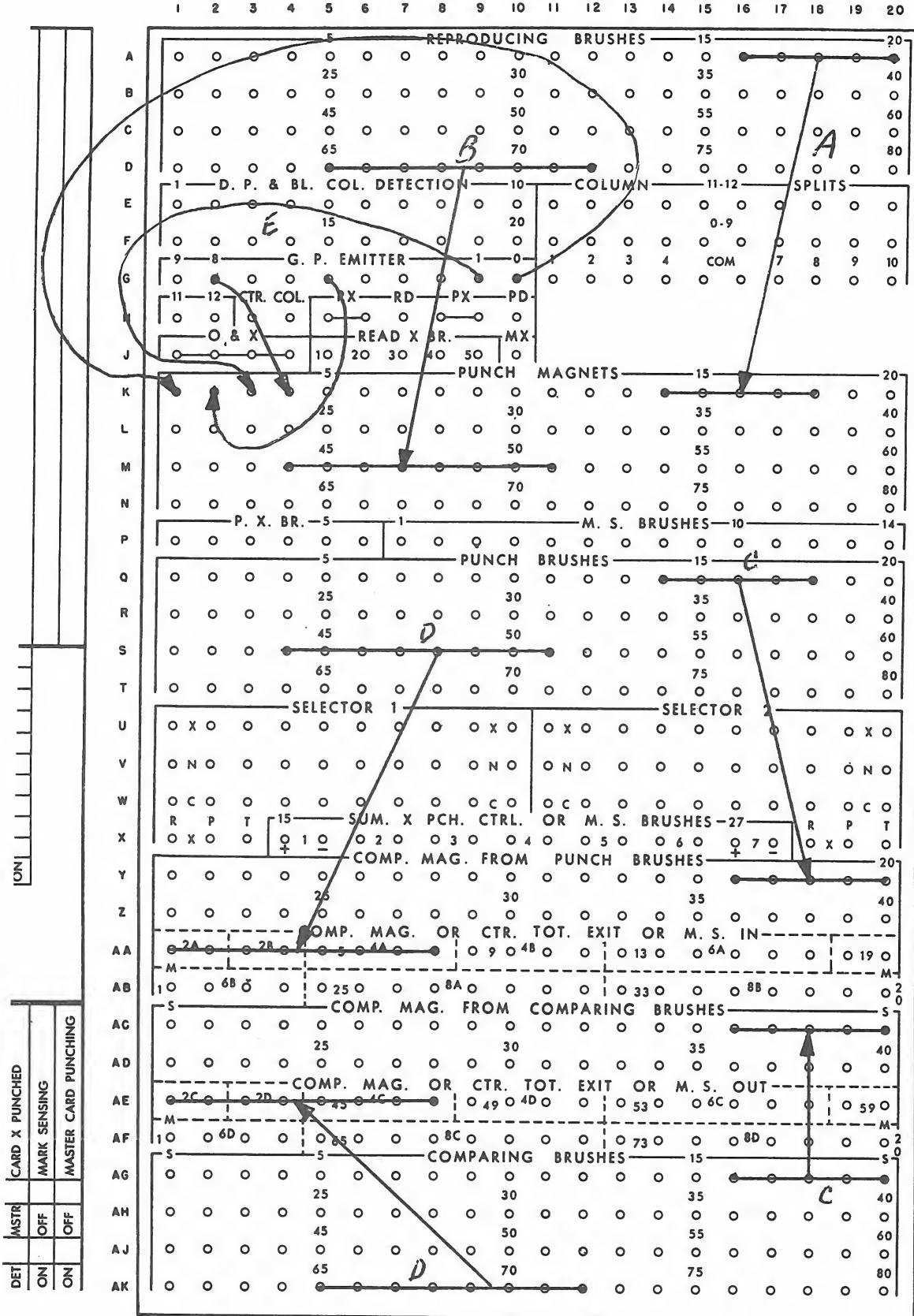
Solution to Problem 2
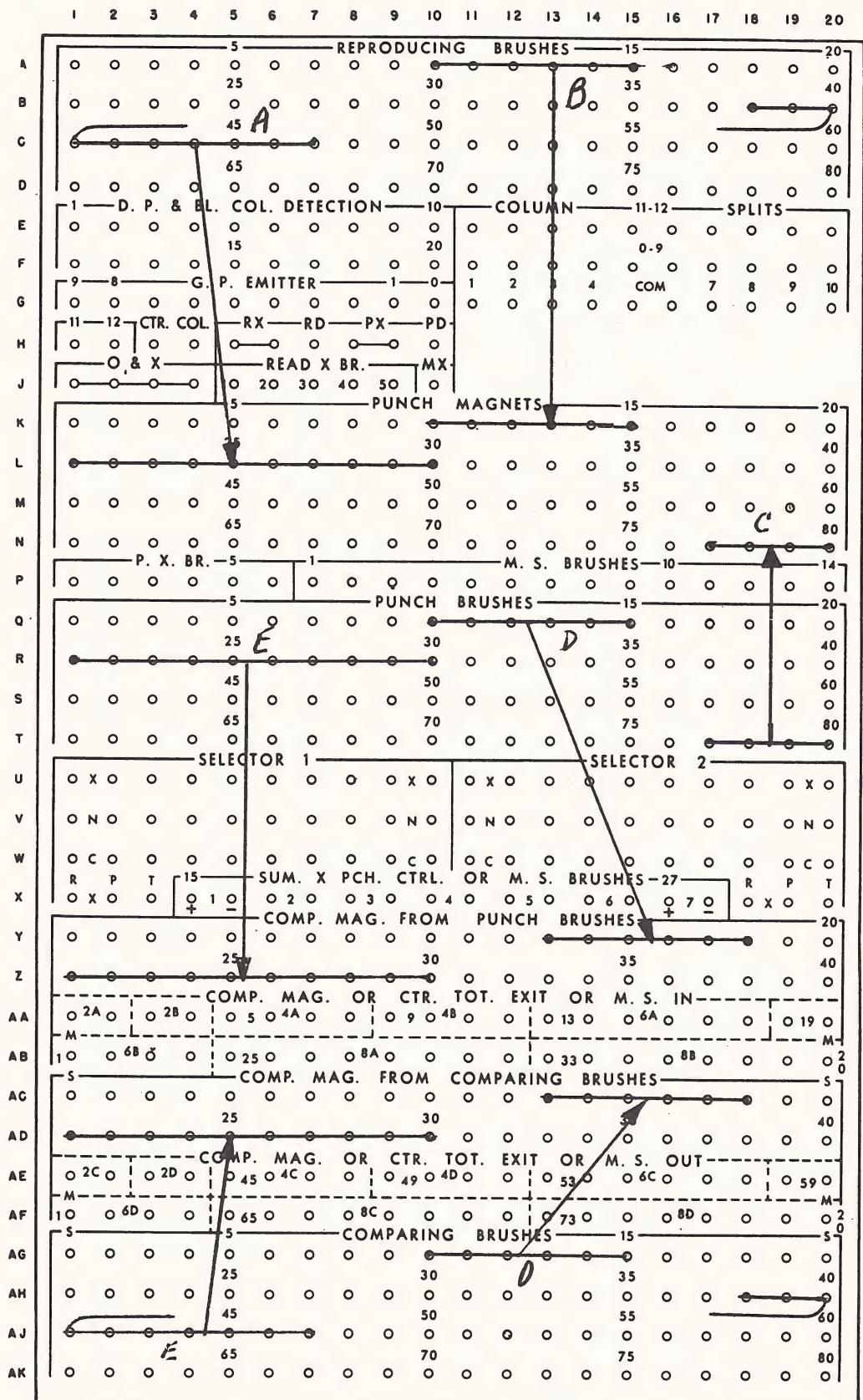
Solution to Problem 3

Notes on Problem 1

A. c.c. 1-4 are reproduced into c.c. 9-12. Information read by the reproducing brushes 1-4 is transmitted to the punching dies 9-12.

B. c.c. 24-32 are reproduced into c.c. 50-58.

C. The information being read by the comparing brushes reading c.c. 1-4 is sent to comparing magnets 3-6. The information being read by the punching brushes reading c.c. 9-12 is also sent to the same comparing magnets 3-6. If they agree, the machine will continue to run. Note here that you may compare any field in any of the available comparing magnets. However, you must be careful that you use the same comparing magnets from the comparing brushes that you use from the punching brushes. Also bear in mind that the columns compared by the comparing brushes are the same as those being read by the reproducing brushes and the columns being compared by the punching brushes are the same as those being punched at the punching dies.

D. We have decided to use comparing magnets 7-15 to compare our second field. We therefore wire from c.c. 24-32 from the comparing brushes (the same columns read by the reproducing brushes) into comparing magnets 7-15; and then we wire from punching brushes 50-58 (the same columns as those punched by the punching dies) into comparing magnets 7-15.

E. The O & X impulse is wired to the Common hub of a column split and from the 11-12 hub to c.c. 79. Only the X impulse can come out of the 11-12 hub.

Notes on Problem 2

A. c.c. 16-20 is reproduced into c.c. 14-18.

B. c.c. 65-72 is reproduced into c.c. 44-51.

C. The punch brush impulses from c.c. 14-18 are directed to comparing magnets 16-20. The comparing brush impulses from c.c. 16-20 are also wired to comparing magnets 16-20.

D. The punch brush impulses from c.c. 44-51 are wired to comparing magnets 41-48. The comparing brush impulses from c.c. 65-72 are also wired to comparing magnets 41-48. Note here that comparing magnets 41-80 are multiple purpose hubs. By this we mean that they perform different functions depending on the job being done. For the reproducing function, they act as entries to the comparing magnets. Their use for other functions will be discussed in later lessons. The 80 comparing magnet entry hubs from the Punching brushes are identified on the diagram as Y-AB, 1-20. The 80 comparing entry hubs from the comparing brushes are identified on the diagram as AC-AF, 1-20.

E. The date 0518 is emitted from the G.P. Emitter to c.c. 1-4. Remember, that when using the G.P. Emitter, a blank card must be placed in front of the cards going into the Punch Feed hopper. When emitting and reproducing, a blank card must also be placed in front of the original deck which is going into the Read Feed hopper. The reproducing portion of this job will be compared by the machine's comparing magnets. We will verify the emitting by sight checking our cards as they come out of the punch stacker.

Notes on Problem 3

A. c.c. 38-47 are reproduced into c.c. 21-30.

B. c.c. 10-15 are reproduced into c.c. 10-15.

C. c.c. 77-80 are gang punched into c.c. 77-80.

D. The punch brush impulses from c.c. 10-15 are sent to comparing magnets 13-18. The comparing brush impulses from c.c. 10-15 are also sent to comparing magnets 13-18.

E. The punch brush impulses from c.c. 21-30 are sent to comparing magnets 21-30. The comparing brush impulses from c.c. 38-47 are also sent to comparing magnets 21-30. A blank card would be placed in front of the original cards going into the Read Feed hopper so as not to reproduce any information into our master date card.

Exercises: Diagram the following exercises on the blank control panel diagrams provided in the back part of this lesson. Compare your solution with the school solution which will also be found in the back part of this lesson.

Refer to Figure 15. It contains two card formats. On the left you will see the Employee Master Card which we will use as our original deck. On the right you will see the Weekly Atten-

dance Card which will be our new format. The exercise will indicate to you the comparing magnets to be used to compare the various fields. The reason for this is merely to make it easier for you to compare your solution with the school solution. Remember, you can use any comparing magnets to compare any columns. Each exercise is a separate job.
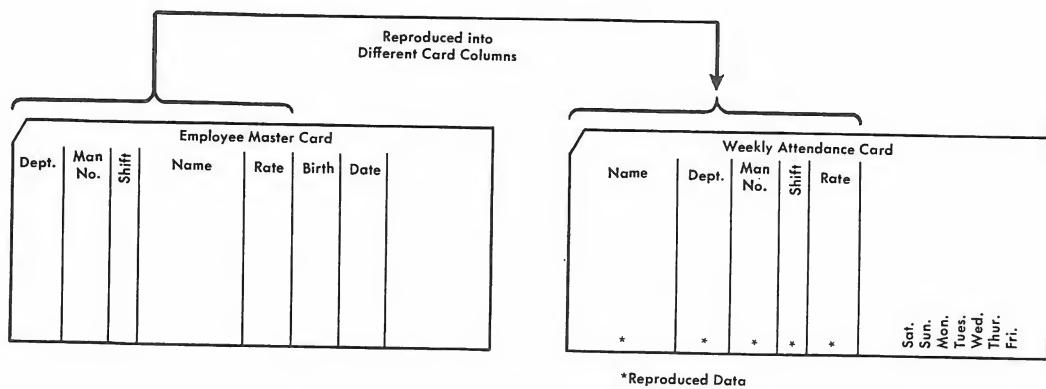
Figure 15.

1. a) Reproduce Dept. c.c. 1-4 into c.c. 22-25. Compare this field in comparing magnets 1-4.

   b) Reproduce Name c.c. 11-30 into c.c. 1-20. Compare this field in comparing magnets 21-40.

   c) Emit an "X" punch in c.c. 65 from the O & X hubs.

2. a) Reproduce Dept. c.c. 1-4 into c.c. 21-24. Compare this field in comparing magnets 13-16.

   b) Reproduce Man No. c.c. 5-7 into c.c. 25-27. Compare this field in comparing magnets 1-3.

   c) Reproduce Rate c.c. 32-36 into c.c. 32-36. Compare this field in comparing magnets 32-36.

   d) Gang punch a date in c.c. 57-60.

3. a) Reproduce Man No. c.c. 5-7 into c.c. 61-63. Compare this field in comparing magnets 43-45.

   b) Reproduce Shift c.c. 8-9 into c.c. 64-65. Compare this field in comparing magnets 10-11.

   c) Reproduce Name c.c. 11-30 into c.c. 21-40. Compare this field in comparing magnets 21-40.

   d) Use the G.P. Emitter and emit the date 0915 in c.c. 1-4.

SUMMARY

Reproducing is the technique used to take information from one deck of cards and place it into another deck of cards either in the same format or in any desired format. Coupled with the reproducing operation, we are given a means of checking and verifying the operation of the machine (comparing). We can at the time we are reproducing gang punch information into the new deck or emit information into the new deck. All these operations can occur at the same time at the rate of 100 cards per minute. We can reproduce one column or all 80 columns. There are no limitations on how many columns can be reproduced.

The card we are reproducing from is placed in the Read Feed Hopper; the cards we are reproducing into are placed in the Punch Feed hopper. Both feeds are synchronized by placing the functional switch "Reproduce" in the ON position. The control panel is wired and inserted and the Start key depressed. From that point on, the machine takes over and reproducing and comparing are automatic.

Information is read by the reproducing brushes, transmitted to the punching dies and punched into the card passing under the dies. The original card is then read by the comparing brushes and the information sent to any comparing magnets. The card which was punched is at the same time read by the punching brushes and this information is sent to the other half of the same numbered comparing magnets used for the reproducing brushes. Should an error be detected, the machine would stop and the "fingers" of the comparing unit would indicate what comparing magnets are unequal. The error would be corrected, the comparing unit reset and the start button pressed to resume operation.

GLOSSARY

Comparing Magnets — those devices used in IBM machines to compare or match information. Each comparing position consists of two magnets. If either is magnetized, an unequal condition is noted. If both are magnetized at the same time an equal condition is noted; also if both are not magnetized, this is treated as equal.

Discrepancy — the term as used here indicates an unequal condition when comparing.

Fingers (comparing) — slivers of metal which are triggered into position when an unequal comparison is sensed. They will be seen directly above the comparing magnet which is unequal.

Format — a given sequence of fields in an IBM card. Might also be termed the layout of the fields in a card.

Multiple Purpose hubs — those hubs on the control panel which have more than one use. Their use depends on the function the machine is performing.

Offset Reproducing — that type of reproducing where the information in the new cards is placed in card columns other than those in which it appears in the original card.

Reproducing — a method of copying varied information from one card into another. This differs from gang punching where we copy the same information from one card to another.

Synchronized Feeding — a condition where cards being fed from the Read Feed Hopper and cards being fed from the Punch Feed Hopper pass through the various stations at the same identical time, zone for zone.

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REPRODUCING BRUSHES

D. P. & BL. COL. DETECTION — COLUMN — 11-12 — SPLITS

G. P. EMITTER

CTR. COL. — RX — RD — RX — PD

O. & X — READ X BR. — MX

PUNCH MAGNETS

P. X. BR. — M. S. BRUSHES

PUNCH BRUSHES

SELECTOR 1 — SELECTOR 2

SUM. X PCH. CTRL. OR M. S. BRUSHES

COMP. MAG. FROM PUNCH BRUSHES

COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN

COMP. MAG. FROM COMPARING BRUSHES

COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT

COMPARING BRUSHES

NOTES

CARD NAME OR FUNCTION

BLANK COLUMN CHECK SWITCHES

X OR DIGIT

ELECTRO NO.

REPRODUCE
SEL REPD AND GP COMP
CARD X PUNCHED
MARK SENSING
MASTER CARD PUNCHING

SWITCHES

DEPT.
NO.
NAME
USE

Solution to Exercise 1

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NOTES

	1 2 3 4 5 6 7 8 9 10
X OR DIGIT	

CARD NAME OR FUNCTION

BLANK COLUMN CHECK SWITCHES

		OFF	ON

REPRODUCE

SEL REPD AND GP COMP

CARD X PUNCHED

MARK SENSING

MASTER CARD PUNCHING

ELECTRO NO.

	OFF	OFF	MSTR	OFF	OFF
	ON	ON	DET	ON	ON
ON	ON				

SWITCHES

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

A — REPRODUCING BRUSSHES —
B
C
D
E — D. P. & BL. COL. DETECTION — COLUMN — 11-12 — SPLITS —
F 0-9
G 9 8 — G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10
H 11 12 CTR. COL. RX — RD — PX — PD
J O & X — READ X BR. — MX
K — PUNCH MAGNETS —
L
M
N — P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14
P — PUNCH BRUSHES —
Q
R
S
T
U SELECTOR 1 SELECTOR 2
V
W R P T — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T
X + 1 2 3 4 5 6 7 +
Y — COMP. MAG. FROM PUNCH BRUSHES —
Z
AA — COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN —
AB — COMP. MAG. FROM COMPARING BRUSHES —
AC
AD — COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT —
AE
AF
AG — COMPARING BRUSHES —
AH
AJ
AK

DEPT.
NO.

NAME
USE

Solution to Exercise 2

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Solution to Exercise 3

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Control panel diagram. Rows labeled A through AK, columns 1 through 20.

Section labels:
- 5 — REPRODUCING BRUSHES — 15 — 20 (rows A–D)
- 1 — D. P. & BL. COL. DETECTION — 10 — COLUMN — 11-12 — SPLITS (rows E–F)
- 9 — 8 — G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10 (row G)
- 11 — 12 — CTR. COL. — RX — RD — PX — PD (row H)
- O & X — READ X BR. — MX — 10 20 30 40 50 (row J)
- 5 — PUNCH MAGNETS — 15 — 20 (rows K–N)
- P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14 (row P)
- 5 — PUNCH BRUSHES — 15 — 20 (rows Q–T)
- SELECTOR 1 — SELECTOR 2 (rows U–X)
- R P T — 15 — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T (row X)
- + — — COMP. MAG. FROM PUNCH BRUSHES — 20 (rows Y–Z)
- COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN (rows AA–AB)
- COMP. MAG. FROM COMPARING BRUSHES (rows AC–AD)
- COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT (rows AE–AF)
- COMPARING BRUSHES (rows AG–AK)

Left side table:
NOTES
CARD NAME OR FUNCTION
X OR DIGIT
ELECTRO NO.

BLANK COLUMN CHECK SWITCHES — 1 2 3 4 5 6 7 8 9 10 — OFF / ON

REPRODUCE
SEL REPD AND GP COMP
CARD X PUNCHED — MSTR
MARK SENSING — DET
MASTER CARD PUNCHING

SWITCHES: OFF / ON

Right side:
DEPT.
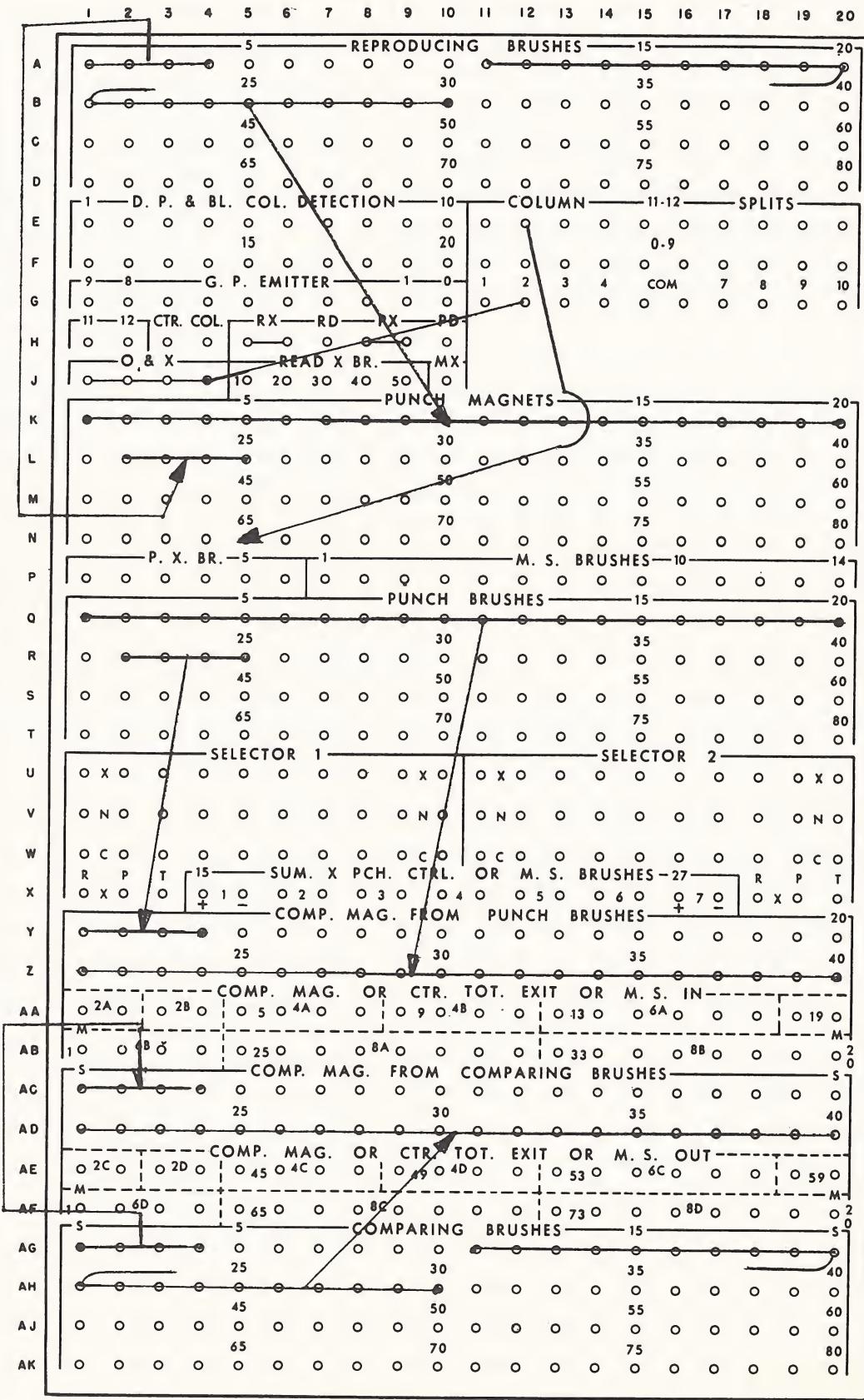NO.
NAME
USE

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION
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FOR SUMMARY PUNCHING – ALPHABETIC ACCOUNTING MACHINE

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Control panel chart. Column numbers 1–20 across the top. Rows A through AK.

- A–D: REPRODUCING BRUSHES (5, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- E–F: D. P. & BL. COL. DETECTION (1, 10, 15, 20) — COLUMN 11-12 SPLITS
- G: G. P. EMITTER (9, 8, 1, 0) 1 2 3 4 COM 7 8 9 10
- H: 11 12 CTR. COL. RX RD PX PD
- J: O & X — READ X BR. — MX (10 20 30 40 50)
- K–N: PUNCH MAGNETS (5, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- P: P. X. BR. -5- 1 — M. S. BRUSHES -10- 14
- Q–T: PUNCH BRUSHES (5, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- U–W: SELECTOR 1 / SELECTOR 2 (R P T / O X O / O N O / O C O)
- X: R P T -15- SUM. X PCH. CTRL. OR M. S. BRUSHES -27- R P T (1 2 3 4 5 6 7)
- Y–Z: COMP. MAG. FROM PUNCH BRUSHES (20, 25, 30, 35, 40)
- AA–AB: COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN (2A 2B 5 4A 9 4B 13 6A 19 / 6B 25 8A 33 8B 2 0)
- AC–AD: COMP. MAG. FROM COMPARING BRUSHES (25, 30, 35, 40)
- AE–AF: COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT (2C 2D 45 4C 49 4D 53 6C 59 / 6D 65 8C 73 8D 2 0)
- AG–AK: COMPARING BRUSHES (5, 15, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)

Left side table:

NOTES

CARD NAME OR FUNCTION

ELECTRO NO.

		X OR DIGIT				
		10 9 8 7 6 5				

BLANK COLUMN CHECK SWITCHES	1 2 3 4 5	OFF / ON

REPRODUCE — ON / OFF
SEL REPD AND GP COMP — ON / OFF
CARD X PUNCHED — MSTR / DET
MARK SENSING — ON / OFF
MASTER CARD PUNCHING — ON / OFF

SWITCHES

DEPT.

NO.

NAME

USE

IBM

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Control panel wiring diagram. Column numbers 1–20 across the top. Row labels A through AK down the center panel.

Rows and section labels:
- A–D: REPRODUCING BRUSHES (5, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- E–F: D. P. & BL. COL. DETECTION — COLUMN — 11-12 — SPLITS (1, 10, 15, 20, 0-9)
- G: 9 8 G. P. EMITTER 1 0 1 2 3 4 COM 7 8 9 10
- H: 11 12 CTR. COL. RX RD PX PD
- J: O & X READ X BR. MX (10 20 30 40 50)
- K–N: PUNCH MAGNETS (5, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- P: P. X. BR. 5 1 M. S. BRUSHES 10 14
- Q–T: PUNCH BRUSHES (5, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- U–X: SELECTOR 1 SELECTOR 2 (X, N, C; R P T; 15 SUM. X PCH. CTRL. OR M. S. BRUSHES 27 R P T)
- Y–Z: COMP. MAG. FROM PUNCH BRUSHES (20, 25, 30, 35, 40)
- AA–AB: COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN (2A 2B 4A 4B 6A 5 9 13 19 M; 6B 8A 8B 25 33 M)
- AC–AD: COMP. MAG. FROM COMPARING BRUSHES (S, 25, 30, 35, 40, S)
- AE–AF: COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT (2C 2D 4C 4D 6C 45 49 53 59 M; 6D 8C 8D 65 73 M)
- AG–AK: COMPARING BRUSHES (5, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)

Left side form fields:
- NOTES
- CARD NAME OR FUNCTION
- X OR DIGIT (1 2 3 4 5 6 7 8 9 10)
- BLANK COLUMN CHECK SWITCHES (1 2 3 OFF ON)
- ELECTRO NO.
- REPRODUCE: ON / OFF
- SEL REPD AND GP COMP: ON / OFF
- CARD X PUNCHED: DET / MSTR
- MARK SENSING: ON / OFF
- MASTER CARD PUNCHING: ON / OFF
- SWITCHES

Right side: DEPT. / NO. / NAME / USE

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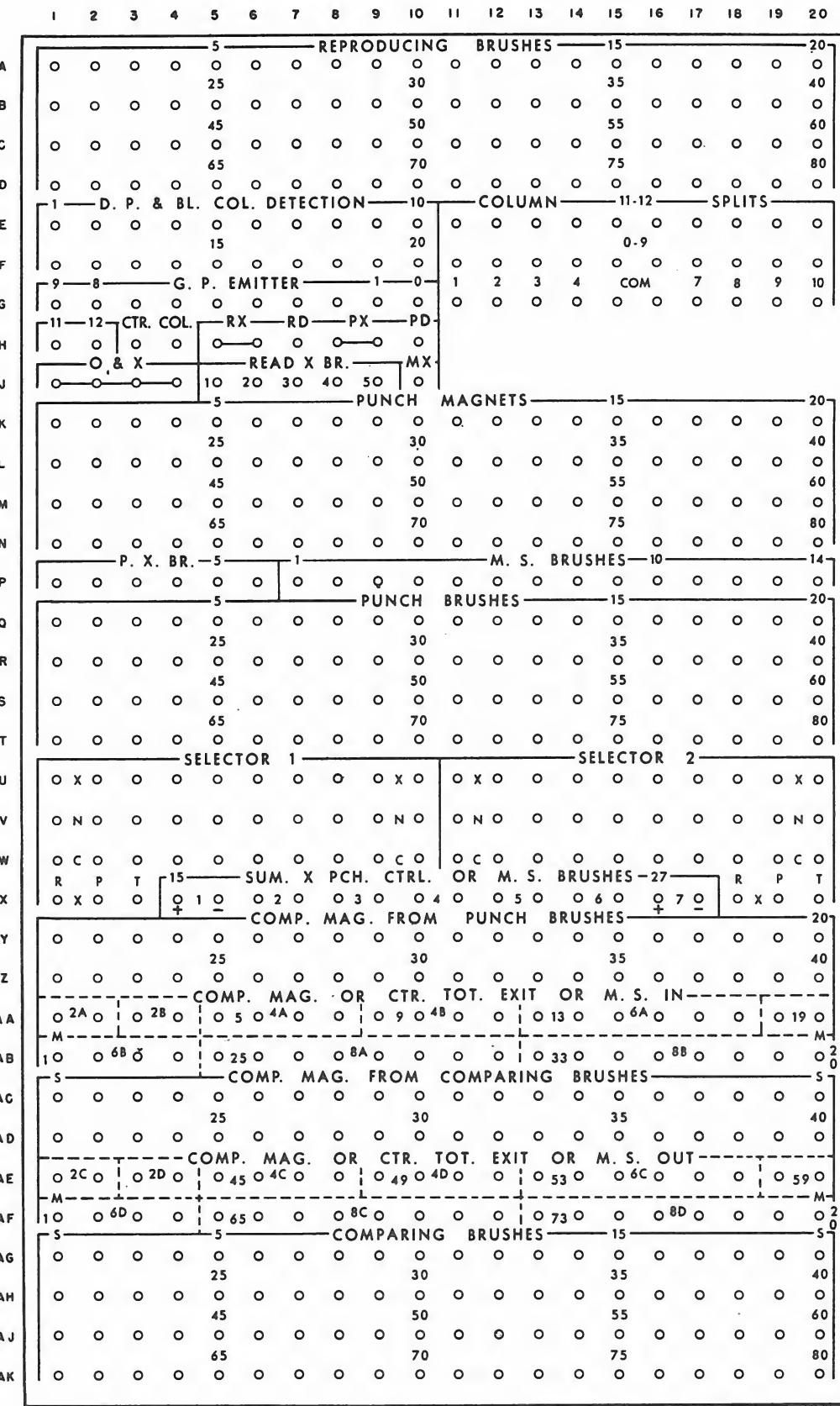
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NOTES

DEPT.

NO.

CARD NAME OR FUNCTION

X OR DIGIT

BLANK COLUMN
CHECK SWITCHES

ELECTRO NO.

REPRODUCE
SEL REPD AND GP COMP
CARD X PUNCHED
MARK SENSING
MASTER CARD PUNCHING

SWITCHES

Column headers: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

A — 5 — REPRODUCING BRUSHES — 15 — 20
B — 25 — 30 — 35 — 40
C — 45 — 50 — 55 — 60
D — 65 — 70 — 75 — 80

E — 1 — D. P. & BL. COL. DETECTION — 10 — COLUMN — 11-12 — SPLITS
F — 15 — 20 — 0-9
G — 9 — 8 — G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10
H — 11 — 12 CTR. COL. — RX — RD — PX — PD
J — O & X — READ X BR. — MX — 10 20 30 40 50

K — 5 — PUNCH MAGNETS — 15 — 20
L — 25 — 30 — 35 — 40
M — 45 — 50 — 55 — 60
N — 65 — 70 — 75 — 80

P — P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14

Q — 5 — PUNCH BRUSHES — 15 — 20
R — 25 — 30 — 35 — 40
S — 45 — 50 — 55 — 60
T — 65 — 70 — 75 — 80

U — SELECTOR 1 — SELECTOR 2 — O X O
V — O N O
W — O C O — R P T

X — 15 — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T
X — + 10 — 20 — 30 — 40 — 50 — 60 — + 70 —

Y — COMP. MAG. FROM PUNCH BRUSHES — 20
Z — 25 — 30 — 35 — 40

AA — COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN — 2A — 2B — 5 — 4A — 9 — 4B — 13 — 6A — 19
AA — M — M
AB — 1 — 6B — 25 — 8A — 33 — 8B — 20

AC — S — COMP. MAG. FROM COMPARING BRUSHES — S
AD — 25 — 30 — 35 — 40

AE — COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT — 2C — 2D — 45 — 4C — 49 — 4D — 53 — 6C — 59
AE — M — M
AF — 1 — 6D — 65 — 8C — 73 — 8D — 20

AG — S — 5 — COMPARING BRUSHES — 15 — S
AH — 25 — 30 — 35 — 40
AJ — 45 — 50 — 55 — 60
AK — 65 — 70 — 75 — 80

NAME

USE

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Control panel wiring diagram with the following labeled sections (rows A–AK, columns 1–20):

- A–D: REPRODUCING BRUSHES
- E: D. P. & BL. COL. DETECTION — COLUMN — 11-12 — SPLITS
- F–G: G. P. EMITTER
- H: CTR. COL. — RX — RD — PX — PD
- J: O & X — READ X BR. — MX
- K–N: PUNCH MAGNETS
- P: P. X. BR. — M. S. BRUSHES
- Q–T: PUNCH BRUSHES
- U–W: SELECTOR 1 / SELECTOR 2
- X: SUM. X PCH. CTRL. OR M. S. BRUSHES
- Y–Z: COMP. MAG. FROM PUNCH BRUSHES
- AA–AB: COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN
- AC–AD: COMP. MAG. FROM COMPARING BRUSHES
- AE–AF: COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT
- AG–AK: COMPARING BRUSHES

Left-hand panel:

NOTES

CARD NAME OR FUNCTION

X OR DIGIT

BLANK COLUMN CHECK SWITCHES: 1 2 3 4 5 6 7 8 9 10 — OFF / ON

ELECTRO NO.

REPRODUCE	SEL REPD AND GP COMP	CARD X PUNCHED	MARK SENSING	MASTER CARD PUNCHING

SWITCHES: ON/OFF, ON/OFF, DET/MSTR, ON/OFF, ON/OFF

DEPT. _____ NO. _____

NAME _____ USE _____

EXAMINATION

INSTRUCTIONS. Your examinations are important to you as they indicate how well you understand the lesson material. Be sure to allow yourself enough time to complete the examination. Read each question carefully and be sure you understand it. Mark your answers in the proper box. Review the exam to be sure that all questions are answered.

1. To reproduce cards you wire from
   a) Punch brushes to punching dies
   b) Punch brushes to reproducing brushes
   c) Reproducing brushes to punching dies
   d) Comparing brushes to punching dies

2. How many reproducing brushes are there?
   a) 1
   b) 45
   c) 60
   d) 80

3. How many comparing positions are standard?
   a) 45
   b) 60
   c) 80
   d) 1

4. Assume that you are reproducing c.c. 1-4 into c.c. 5-8. The comparing brushes have been wired to comparing magnets 9-12. To complete the diagram wire —
   a) punching magnets 5-8 into comparing magnets 9-12.
   b) punching brushes 5-8 into comparing magnets 9-12.
   c) punching brushes 1-4 into comparing magnets 9-12.
   d) punching brushes 5-8 into comparing magnets 1-4.

5. Assume that in running the job in problem 4 above, the finger for comparing magnet 12 was triggered. What columns would you check?
   a) Column 1 on the original card and column 5 on the new card.
   b) Column 4 on the original card and column 5 on the new card.
   c) Column 4 on the original card and column 8 on the new card.
   d) Column 8 on the original card and column 4 on the new card.

6. Which of the following statements is True?

   a. It is possible to reproduce and use the G. P. Emitter in the same operation.

   b. Only 45 columns can be reproduced at one time.

   c. The mechanical fingers in the comparing unit indicate the card columns which are unequal.

   d. All 80 comparing magnets are standard.

7. When reproducing —
   a) all functional switches are OFF
   b) all functional switches are ON
   c) the Reproduce switch is ON
   d) the Reproduce switch is OFF

8. You are told to reproduce c.c. 21-24 into c.c. 27-30. Which of the following steps would be incorrect. Use comp. magnets 1-4.
   a) wire from reproducing brushes 21-24 into punching dies (magnets) 27-30.
   b) wire from punching brushes 21-24 into comparing magnets 1-4.
   c) wire from punching brushes 27-30 into comparing magnets 1-4.
   d) wire from comparing brushes 21-24 into comparing magnets 1-4.

9. You are told to reproduce c.c. 75-80 into c.c. 1-6 and also to emit an X in c.c. 10 using the O & X emitter. Use comp. magnets 5-10. Which of the following steps would be incorrect.
   a) wire from reproducing brushes 75-80 into punching dies 1-6.
   b) wire from the O & X emitter to the Common of a column split; and from the 11-12 hub to c.c. 10.
   c) wire from punching brushes 1-6 to comparing magnets 5-10.
   d) wire from comparing brushes 1-6 to comparing magnets 5-10.

10. You are told to reproduce c.c. 11-15 into c.c. 2-6 and also to gang punch c.c. 74-78. Which of the following statements is false.
    a) It is possible to gang punch and reproduce at the same time.
    b) Since gang punching is part of the job, the reproduce switch is OFF.
    c) wire from reproducing brushes 11-15 into punching dies 2-6.
    d) wire from punching brushes 74-78 into punching dies 74-78.

I.B.M. DATA PROCESSING
AND COMPUTER PROGRAMMING

LESSON No. 10

TABLE OF CONTENTS

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10.1 Interspersed Gang-Punching

In our standard gang punch operation, we place our master card in front of our detail cards and then we place all the cards in the Punch-Feed Hopper. All the functional switches would be in the Off position — the control panel would be wired from Punch Brushes to Punch Magnets and by pressing the Start key, we would begin our gang punch operation. The net result of gang-punching is that information in the master card is copied back into the detail cards.

There are many times when we have multiple groups of cards to be gang punched. By this I mean that we may have hundreds or thousands of master cards which are to be placed in front of detail cards and then gang punched. Should we process each group separately, we would have a very difficult time consuming operation since each group would have to be fed into the machine by itself. Should we place all the groups into the machine at the same time, we get a result known as lacing, (the information from the last detail card in group 1 is overpunched into the master card for group 2.) Let us look at a simple example of what would happen should we attempt to gang punch a number of groups of cards at one time. Assume that we are gang punching employee number which is c.c. 1-4. We have three master cards; in back of each master card we have two detail cards. Listed below is a representation of the cards as they stand in the Punch-Feed Hopper prior to being processed:

	c.c. 1-4
Detail	Blank
Detail	Blank
Master	6509
Detail	Blank
Detail	Blank
Master	1376
Detail	Blank
Detail	Blank
Master	4820 (First card in machine)

The first card through the machine would be the master card for employee 4820. This number would be gang punched back into the first detail card, and from the first detail card it would be punched back into the second detail card. Now however, the information in the second detail card would be punched back into the second master card. In c.c. 1 of the second master card we would have a 1 punch and a 4 punch; in c.c. 2 we would have a 3 punch and an 8 punch; in c.c. 3 we would have a 7 punch and a 2 punch; and in c.c. 4 we would have a 6 punch and a 0 punch. This is known as lacing and is to be avoided at all costs as it destroys the information in the second master card and all following cards.

To complete our example, the two detail cards following the second master card would be punched exactly as the second master card was punched. However, we would again overpunch the third master card so that it would have a 6 punch, a 1 punch and a 4 punch in c.c. 1; a 5 punch, a 3 punch and an 8 punch in c.c. 2, etc. The third master card would have three punches in each column as would all the detail cards that follow it. If you are to assume that we could have had hundreds of master cards, you should be able to see that we would get as an end result a meaningless group of cards punched in all possible zones.

In order to process a group of cards which contain multiple master cards we must, in order to get correct results, suspend the punching into master cards as they pass under the Punch Magnets. Obviously, the machine must have some way of knowing which cards are master cards and which are detail cards. Once again, we are going to employ our use of the "control punch" as a means of distinguishing between cards. At the beginning, let us say that all master cards have an identifying X punch which we will use to distinguish master cards from detail cards.
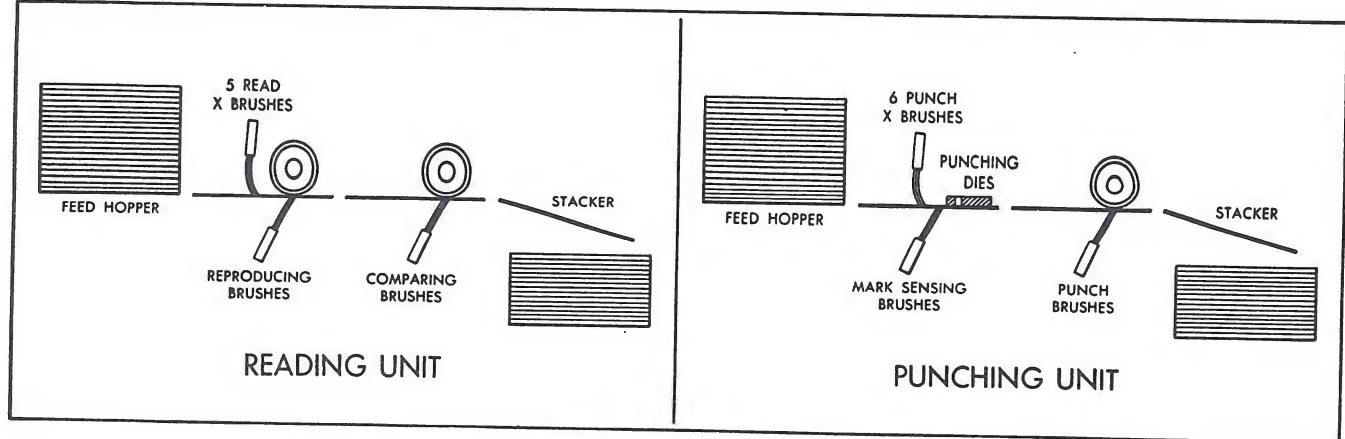
Figure 1. Read and Punch Unit Schematic

Let us examine Figure 1 which is a schematic of the Punch and Read Feeds of the 514 Reproducer to see how this X control punch is used.

The first station under which a card passes as it feeds from the Punch-Feed Hopper is called the "6 punch X brush" station. At this station, there are 6 movable brushes which can be set to read any column. Each of them has a number (from 1-6).

Figure 2. X Brushes In Position

Figure 2 illustrates how the brushes appear in the machine. They sit on a ledge which is calibrated from 1-80 to correspond to the 80 columns in the card. They can be set over any column in the card very simply by loosening the screw that holds them in place and moving them to the columns desired. Let us assume for the balance of this lesson that they are set over the following columns:

Brush 1 — c.c. 10
Brush 2 — c.c. 36
Brush 3 — c.c. 53
Brush 4 — c.c. 58
Brush 5 — c.c. 65
Brush 6 — c.c. 72

These brushes have the ability to read X punches only. Note that they read the X punch before the card passes through the punch magnet station. Therefore, we can use this X punch to control the operation of the machine.

One more point — note that the first station on the Reading Unit side of the machine is called the "5 Read X Brush" station. Here we have 5 brushes which have the same characteristics as the 6 Punch X brushes. They can be positioned to read any column in the card and they will read X punches only. Let us assume that they are positioned as follows:

Brush 1 — c.c. 10
Brush 2 — c.c. 36
Brush 3 — c.c. 53
Brush 4 — c.c. 58
Brush 5 — c.c. 65

We will discuss the function of the 5 Read X brushes later on in this lesson.

Figure 3.

Refer to Figure 3 which illustrates the top portion of the reproducer control panel.

The X impulse read by any of the 6 punch X brushes would be available from the P. X. Br. hubs (row P, hubs 1-6.) Should there be an X in c.c. 10, this impulse would be available from P.X. Br. hub 1; should there be an X in c.c. 58, this impulse would be available from P. X. Br. hub 4.

To suspend punching for those cards which contain control X punches, the P. X. Br. impulse is wired to either of the hubs marked PX (row H, hubs 8-9.) Since these two hubs are common, an impulse wired to either of them will work.

Now refer to Figure 4 for the correct method of wiring the Reproducer to gang punch a group of cards which contain multiple master cards. Note that the master cards all have an X control punch in c.c. 65.

Figure 4.

Notes on Figure 4

A. Punch X Brush 5 will read the X punch in c.c. 65 and transmit this impulse to the PX hubs. This will suspend punching for all X65 master cards.

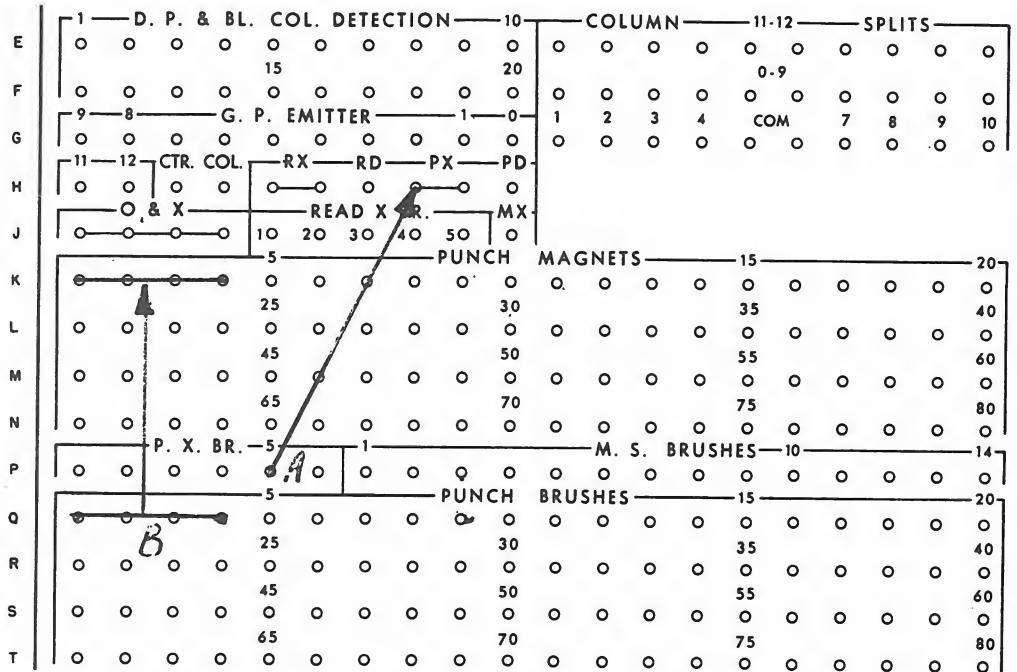B. c.c. 1-4 are wired routinely for gang punching. Our gang punch operation will continue until a master card passes under the punch magnets. The machine will not punch into the master card but will permit it to merely pass through.

Problem: Assume we have a deck of master cards which are punched as follows:

Part No. in c.c. 5-8.
Price in c.c. 20-25.

All master cards have an X in c.c. 65.

We also have a deck of detail cards which have in them the field Part No. in c.c. 5-8. We are required to gang punch the price from the master card into the detail cards which have the same Part No. In order to arrange our cards in sequence by Part No. with the master card in front of the detail cards we place our deck of master cards in front of our deck of detail cards and sort all of them on c.c. 8, then c.c. 7, then c.c. 6 and then c.c. 5. The master cards now would be interspersed among the detail cards. A sample of our combined deck is shown in Figure 5.
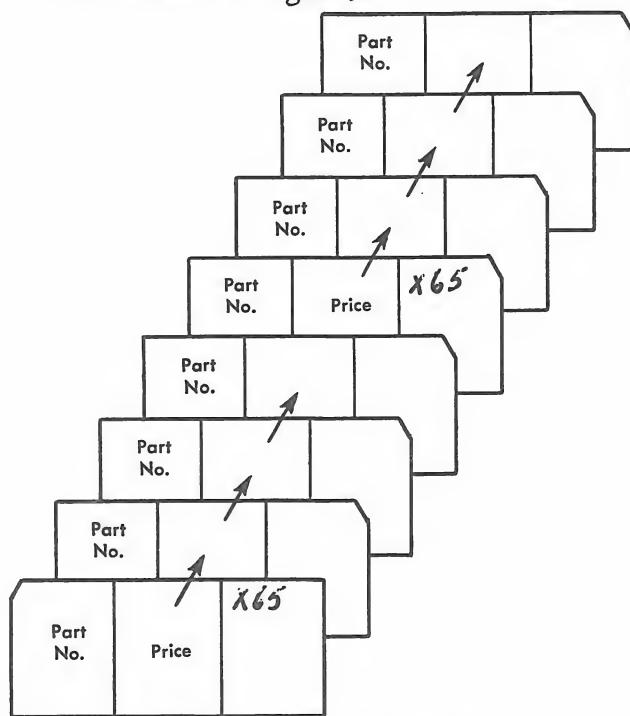
The control panel diagram used to do this interspersed gang-punching job is illustrated in Figure 6.

Notes on Figure 6

A. c.c. 20-25 are wired routinely for gang punching.

B. Punch X Brush 5 is set to read c.c. 65. This impulse will be transmitted to the PX hubs to suspend punching for all X65 master cards. (Note that if the master card X punch had been in c.c. 53, we would have wired P. X. Br. 3 to the PX hub.)

One more point before we begin our exercises in interspersed gang punching. In the problems we have discussed so far in this lesson, we have been gang punching from master cards which contain an X control punch into detail cards which do not contain an X control punch. This is called X to NX punching. For this type of an operation all of our functional switches would be in the OFF position.

It is also possible to reverse this situation; that is to have the X control punch in all the detail cards and not in the master card. This type of interspersed gang punching is called NX to X. In both cases, the control panel wiring is *exactly* the same. The only difference in operating technique is that the functional switch called "card x punched Detail-Master", the right hand switch is in the ON position (down). At this time, the reproducer will suspend punching for all NX cards and will gang punch the X cards.
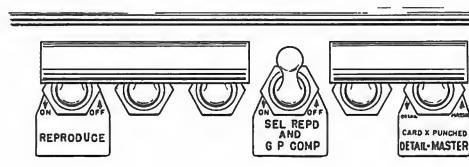
Figure 7. Functional Switches

Figure 5. Sample Deck of Cards
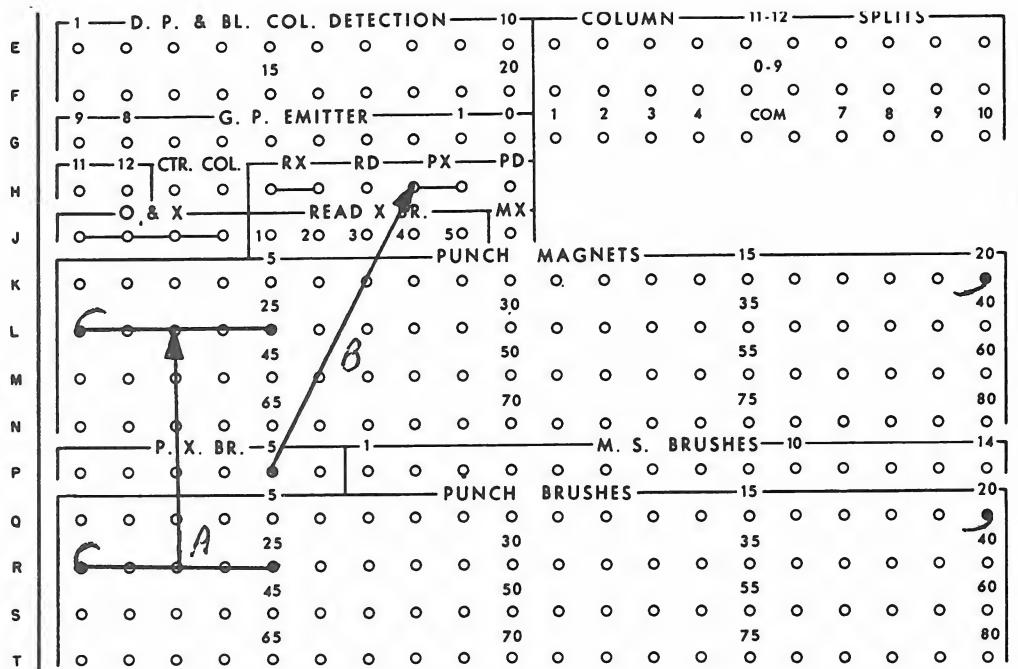
Figure 6.

Exercises: Diagram the following exercises on the blank control panel diagrams provided in the back part of this lesson. Compare your solution with the school solution which will also be found in the back part of this lesson.

1. a) All master cards have an X in c.c. 10.

   b) The master cards have been placed in front of the detail cards and they all have been sorted on c.c. 5-6 which is a field called salesman No. We now have to intersperse gang punch the salesman's name from master cards to detail cards. The salesman's name is in the master cards in c.c. 37-52.

   c) Note that on the control panel diagram there is some blank space under the column split hubs. In this blank space indicate whether the functional switch is set to Master (OFF), or Detail (ON).

2. a) All detail cards have an X in c.c. 36.
   b) The master cards have been placed in front of the detail cards and they all have been sorted into sequence by Employee Number, c.c. 9-12. We are to intersperse gang punch the hourly rate, which is in c.c. 63-67.

   c) On your diagram, indicate the setting of the functional switch at either Master or Detail.

Figure 8 illustrates how the cards would appear as they are placed in the machine.

Figure 8. Sample Deck of Cards

10.2 Verification of Interspersed Gang

The usual method employed to check or verify simple gang punching is the one called sight checking. To sight check a deck of cards which have been gang punched, we joggle them, hold them up to the light and we should be able to see daylight through all the c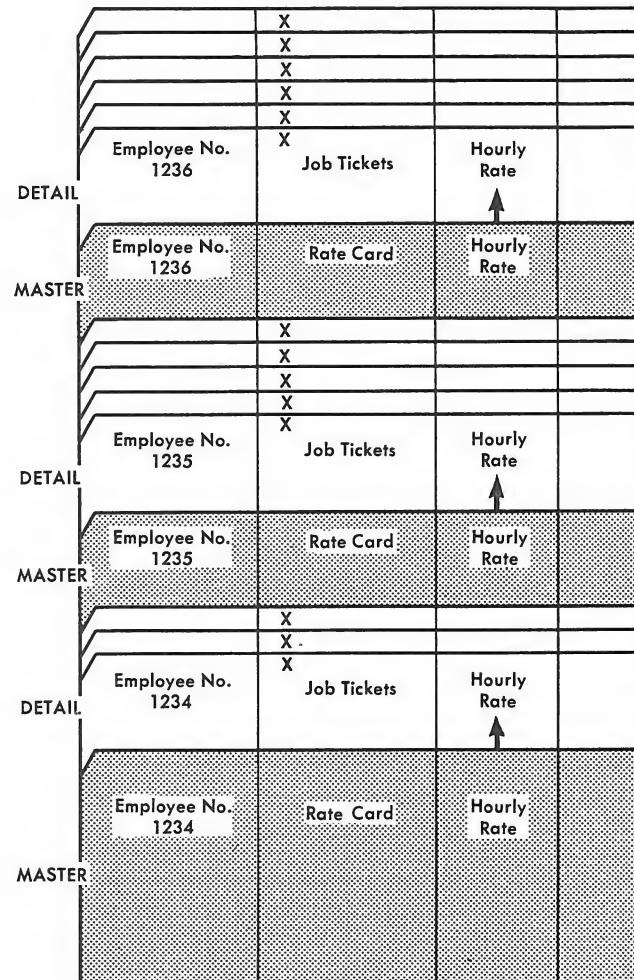olumns which have been punched. We could, of course, use the sight check technique to verify interspersed gang punching but we would be faced with the time-consuming chore of checking hundreds or thousands of small groups.

We know that the reproducer has the ability to compare fields. We used this feature to compare the results of a reproducing operation. In effect, when we sight check cards we are comparing all of them to see if they are equal. In order to verify our interspersed gang punching job, we want to compare all of the detail cards of a group with its master card. We do not however, want to compare the last detail card of a group with the master card which follows it since both cards belong to different groups. Let us look at an example. I have listed below a sample set of cards which are to be interspersed gang punched.

	c.c. 1-4
Detail	Blank
Detail	Blank
Master	6509
Detail	Blank
Detail	Blank
Master	1376
Detail	Blank
Detail	Blank
Master	4820 (first card in machine)

Assume that all master cards have an X in c.c. 58. To intersperse gang punch this job we would wire a control panel as illustrated in Figure 9.
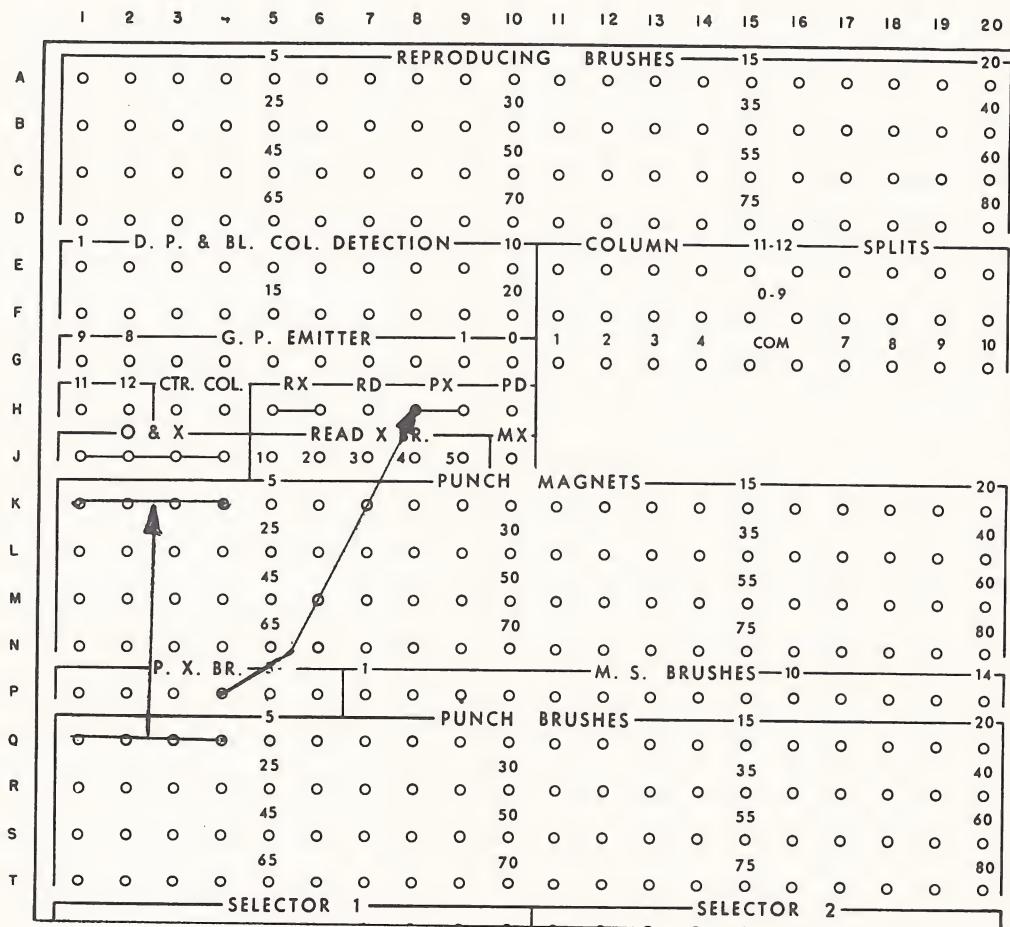

Figure 9.

When we had completed our gang punch operation, the cards would appear as follows:

	c.c. 1-4
Detail	6509
Detail	6509
Master	6509
Detail	1376
Detail	1376
Master	1376
Detail	4820
Detail	4820
Master	4820 (first card in machine)

If you were to verify these cards manually, by inspecting them, you would actually check the punching in the first master card (4820) with the first detail card; then the first detail card against the second detail card. Since the next card is the master card for group 1376, ycu would expect it not to agree with the preceding detail card and in effect you would *suspend comparison* for this master card. You would however, compare the master card for group 1376 with the detail cards that followed it. You would then suspend comparison for the next master card (6509) and compare it only with the detail cards that follow it.

Let us see how the reproducer compares the result of an intersperse gang punch operation.

Figure 10 is an illustration of both the Reading and Punching Units of the 514 Reproducer. We know that interspersed gang punching requires the use of the Punching unit only. Cards are gang punched by wiring from the punch brushes to the punching dies. Punching is suspended for master cards when one of the 6 Punch X Brushes reads an X punch in the master card (for X to NX jobs).
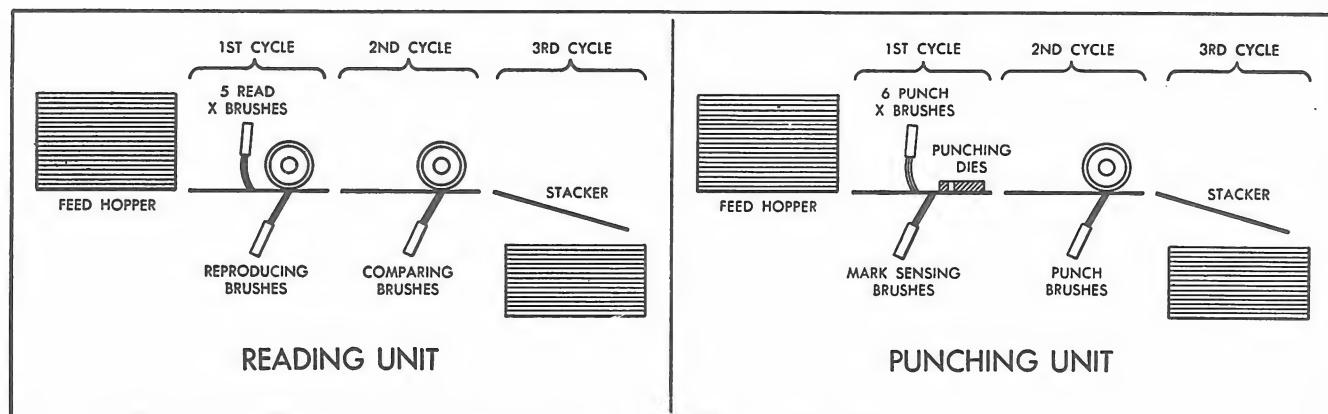
Figure 10. Read and Punch Unit Schematic

The verification of the interspersed gang punch operation is going to take place in the Reading Unit. Those cards which have been interspersed gang punched are taken out of the Punch Stacker and placed in the Read Feed Hopper. In order to get the Read Feed to operate we set our third functional şwitch (Sel Repd and G P Comp, the middle switch in Figure 11) in the ON position.
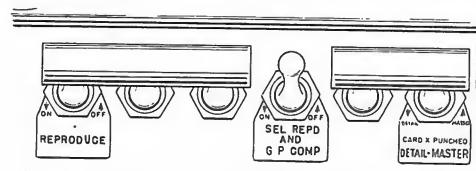
Figure 11. Functional Switches
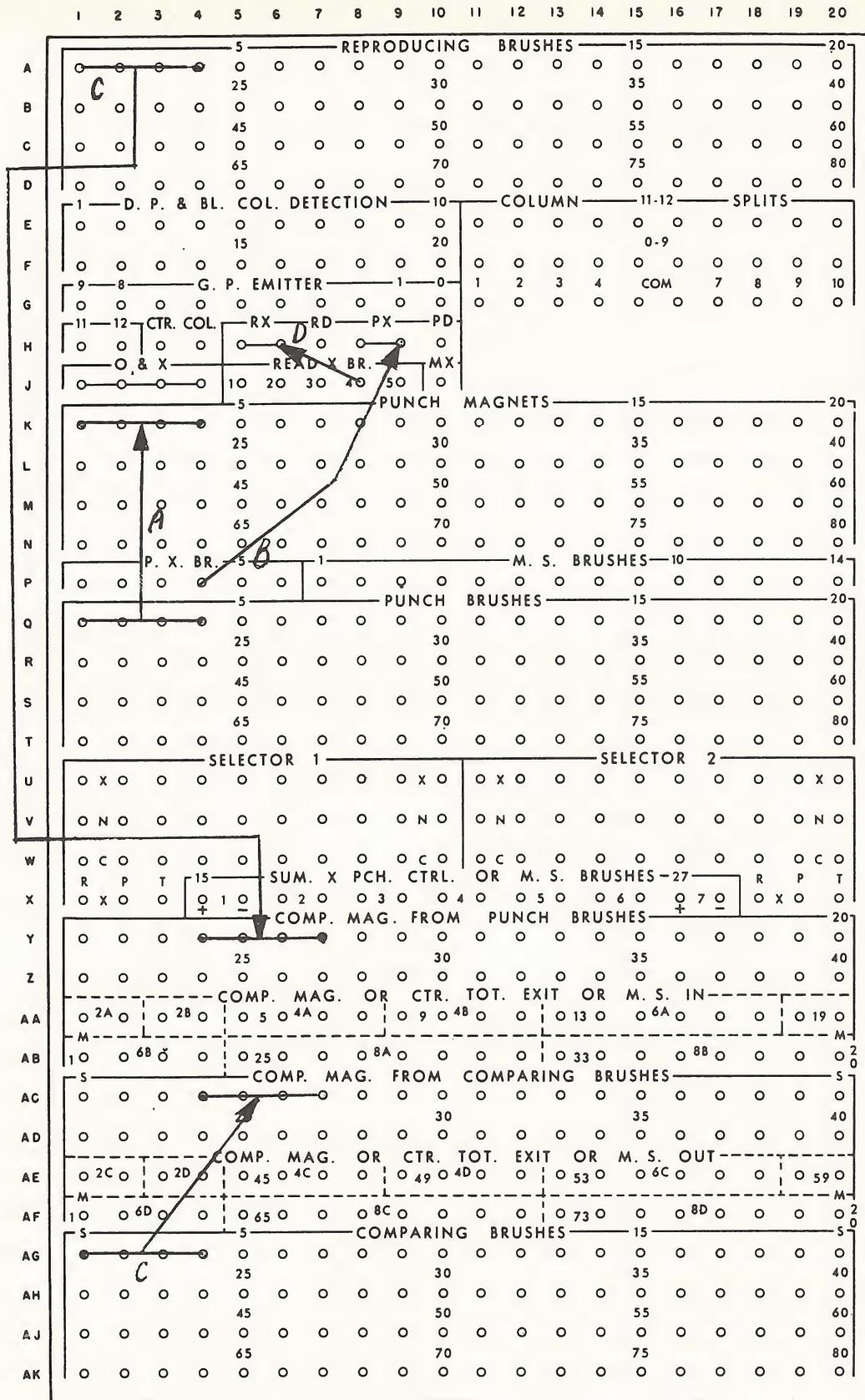
Figure 12. Interspersed Gang Punching and Comparing

Now both feeds are operating. They are not operating in synchronization as they would in a reproduce operation, but it is not necessary that they be synchronized.

In order to verify interspersed gang punching, the card at the comparing brushes is compared with the card at the reproducing brushes unless the card at the reproducing brushes is recognized by the machine as being a master card, in which case comparison is suspended.

The 5 Read X Brushes are used to read Master cards. If you recall, we set them over specific columns earlier in this lesson. Let us look at an adjusted control panel diagram to intersperse gang punch c.c. 1-4. The master card has an X in c.c. 58. See Figure 12.

Notes on Figure 12

A. c.c. 1-4 are wired to gang punch.

B. P. X. brush 4 set on c.c. 58 is wired to PX to suspend punching for X58 master cards.

C. As cards enter the punch stacker they are removed and placed in the Read Feed Hopper. With the G.P. Comp. switch ON, both feeds will run. c.c. 1-4 are read by the comparing brushes and sent to comparing magnets 4-7; c.c. 1-4 in the next card are read by the reproducing brushes and sent to the other. half of comparing magnets 4-7. If equal, the machine will continue to run. If unequal the machine will stop and the fingers of the comparing unit will indicate the comparing magnets which sensed the unequal condition.

D. Comparing for master cards is suspended by wiring from Read X Brush 4 (set on c.c. 58) to RX.

Since this is an X to NX job, Detail-Master switch is set in the OFF position to Master. If this were a NX to X job the Detail-Master switch would be set to the ON or Detail position which would cause Punching and Comparison to be suspended for NX master cards.
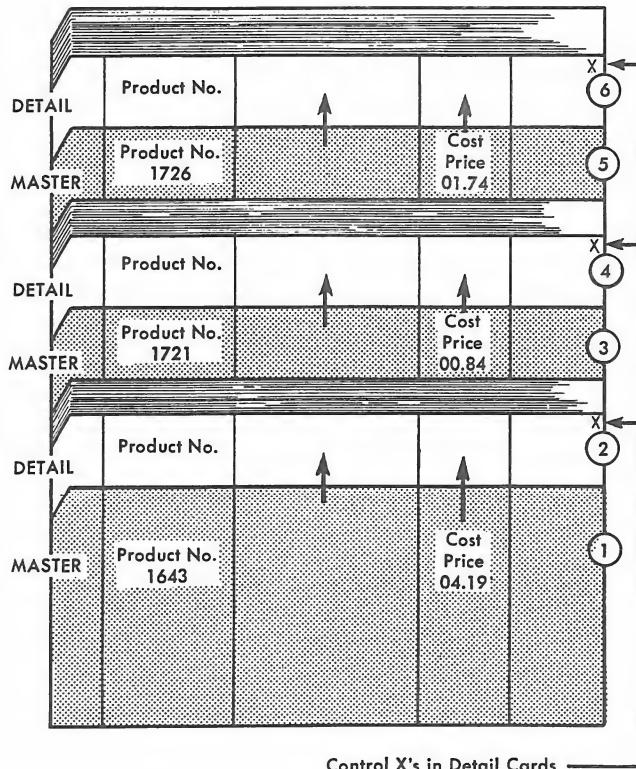
Figure 13. Sample Deck of Cards

Problem: Refer to Figure 13. Our deck of Product Master cards has been placed in front of our deck of Product detail cards and sorted into sequence by Product No., c.c. 5-10. We are to intersperse gang punch the cost price (c.c. 68-74) from the NX masters to the X65 detail cards. We are then going to verify our gang punching job to see that the cost price has been punched correctly and also to see that we have a master card for every Product No. found in the Detail cards. For example, assume that the second master card (for product 1721) is missing. The detail cards would sort in exactly the same place they are now, in back of the detail cards for Product No. 1643. They would then be punched with the information from the master card for Product No. 1643. We would want to detect this before processing these cards any further. Refer to Figure 14 for the solution to this problem.
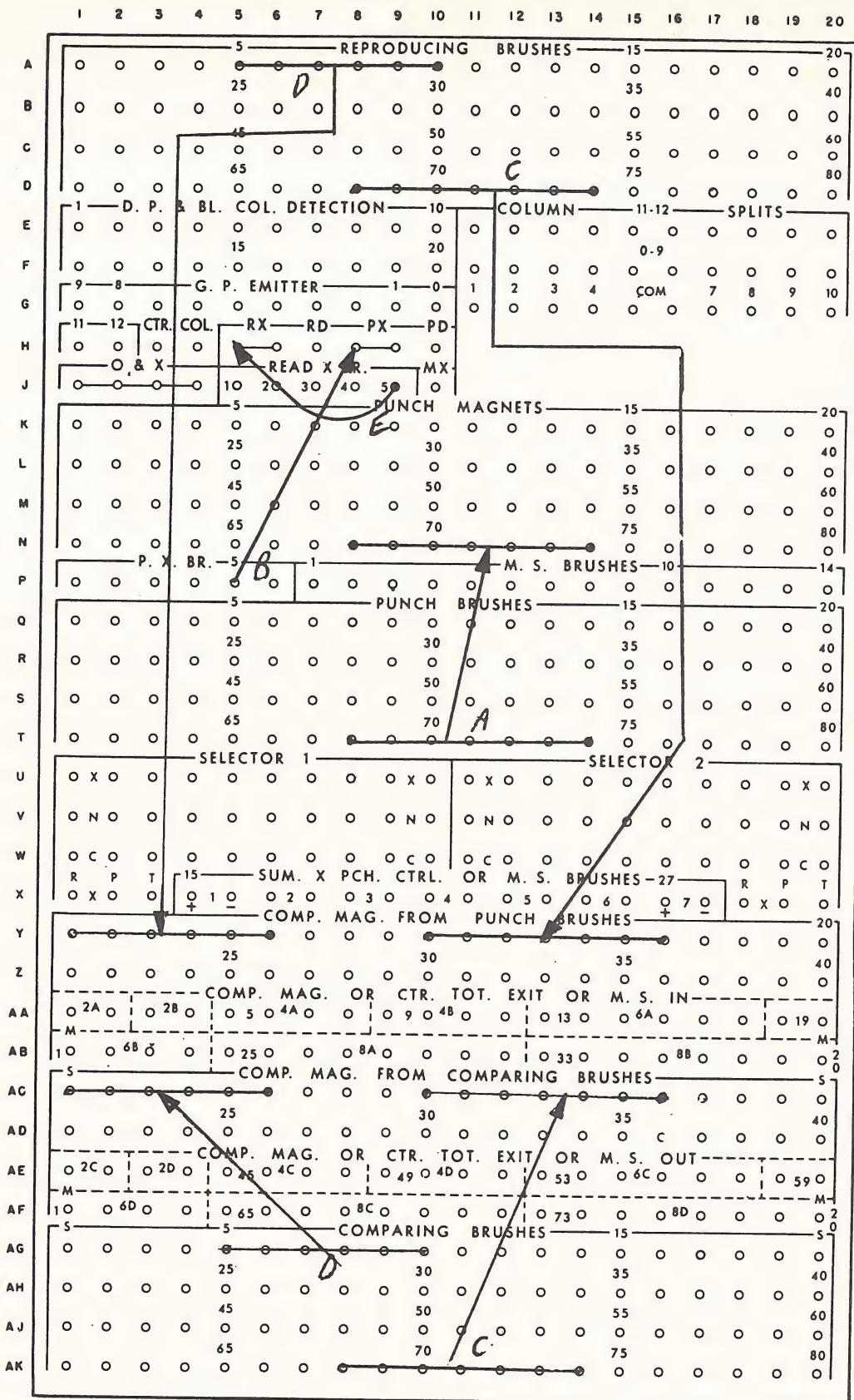
Figure 14.

Notes on Figure 14

A. c.c. 68-74 wired routinely for gang punching.

B. P. X. Br. 5 wired to PX hub. This brush is set to read X65 cards. With the Detail-Master switch set to Detail, punching will be suspended for NX 65 master cards.

C. c.c. 68-74 wired from comparing and reproducing brushes to comparing magnets 10-16. This wiring will compare the gang punching of the cost price field.

D. c.c. 5-10 wired to comparing magnets 1-6 from both comparing and reproducing brushes. This will compare all the detail cards within a group with the master card preceding them to see that they are all equal (for the same Product No.)

E. Read X brush 5 (set on c.c. 65) wired to RX hub to suspend comparison for all NX master cards.

A missing master card or a detail card which is mis-sorted will cause one or more of comparing magnets 1-6 to indicate an unequal condition.

The G.P. Comp. switch would be ON.

*Exercises*: Diagram the following exercises on the blank control panel diagrams provided in the back part of this lesson. Compare your solution with the school solution which will also be found in the back part of this lesson.

3. a) You are given a deck of master item cards which contain the field item No. in c.c. 21-23, item description in c.c. 24-40 and item price in c.c. 53-58.

   b) You are also given a deck of item detail cards which contain the field item No. in c.c. 21-23 and an X punch in c.c. 10.

   c) The master cards are placed in front of the detail cards and sorted on item No. c.c. 21-23.

   d) Prepare a control panel diagram to intersperse gang punch from NX to X, the item description and item price fields. Compare both these fields and also compare the item number field to

check for missing master cards or mis-sorted detail cards.

   e) Use comparing magnets 1-3 to compare item No.; 24-40 to compare item description; and 4-9 to compare item price.

   f) Check the early portion of this lesson for the card columns that the PX and RX brushes are set on.

4. a) You are given a deck of master cards which contain an X in c.c. 53, the field catalog No. in c.c. 15-19, the field color in c.c. 21-24, the field description in c.c. 65-74.

   b) You are also given a deck of detail cards which contain the field catalog No. in c.c. 15-19.

   c) The master cards are placed in front of the detail cards and sorted on catalog No. c.c. 15-19.

   d) Prepare a control panel diagram to intersperse gang punch from X to NX, the fields color and description. Compare both these fields and also the catalog No. field to detect missing master cards or mis-sorted detail cards.

   e) Use comparing magnets 15-19 for comparing catalog No.; 41-44 to compare color; and 31-40 to compare description.

5. a) You are given a deck of cards which have been sorted into sequence by the employee number field, c.c. 1-4. The master cards, which contain an X in c.c. 36 are in front of the detail cards. We are to intersperse from the master cards to the detail cards the fields gross pay (c.c. 53-58), Social Security No. (c.c. 21-29), and No. of Dependents (c.c. 45-46).

   b) Use the following comparing magnets for the indicated fields: Employee No. (magnets 1-4); Gross pay (magnets 5-10); Social Security No. (magnets 11-19); No. of Dependents (magnets 39-40).

SUMMARY

The three basic functions of the 514 Reproducer are gang punching (including emitting), reproducing and interspersed gang punching.

The gang punch operation results in the copying of information from a single master card into all the detail cards in back of it. For this operation all of our functional switches would be OFF. The Reproduce function permits us to create an entirely new deck of cards from an original deck or to take information from one deck and place it in another. Reproducing requires that both feeds are synchronized. This is accomplished by turning the Reproduce functional switch to its ON position. By using the comparing magnets we can check the operation of the machine. We can also incorporate a gang punch operation at the same time we are reproducing. Interspersed gang punching assumes that we have multiple master cards.

We will always check the operation of our machine in an intersperse gang punch job so that the functional switch G.P. Comp. will be ON.

We have the option of having our control X punch in either the master or the detail cards. Should it be in the master card the Master-Detail functional switch is set to Master; should it be in the detail cards, this switch is set to Detail.

Our PX and RX brushes are pre-set to read the columns the control X is punched in. This will cause the machine to suspend punching or comparison for our master cards.

At this point I would like to mention that it is possible for the reproducer to be equipped with selectors. The uses of selection in the reproducer are very limited, and they play no part in our three basic applications.

GLOSSARY

Card X Punched Detail-Master Switch — this is the switch located at the right side of our three functional switches. Its setting indicates to the machine whether punching and comparison are to be suspended for X cards or for NX cards. Should our master cards contain an X control punch, this switch would be in the OFF position (at Master); should the X control punch be in the detail cards, this switch would be in the ON position (at detail).

G. P. Comp. Switch — this switch is ON to compare the results of an intersperse gang punch operation. It causes the Read Unit to feed cards. It is the middle switch.

Lacing — this describes a condition caused by punching information into columns which already have punching in them. In effect, you destroy the information in those columns being punched.

NX to X — one possible type of interspersed gang punch operation. In this situation, the X control punch is in the Detail cards.

PX hub — impulses read by the PX brushes are directed to this hub to cause suspension of punching for X or NX masters depending on the setting of the Detail-Master switch.

Overpunch — same as lacing.

Punch X Brush — there are 6 movable brushes which are positioned over selected columns to read X punches for intersperse gang punch control. These are on the Punch side of the machine.

RX hub — impulses read by the RX brushes are directed to this hub to cause suspension of comparison for X or NX masters depending on the setting of the Detail-Master switch.

Read X Brush — there are 5 movable brushes which are positioned over selected columns to read X punches for intersperse gang punch control. These are on the Read side of the machine.

X to NX — another possible type of interspersed gang punch operation. In this situation, the X control punch is in the Master cards.
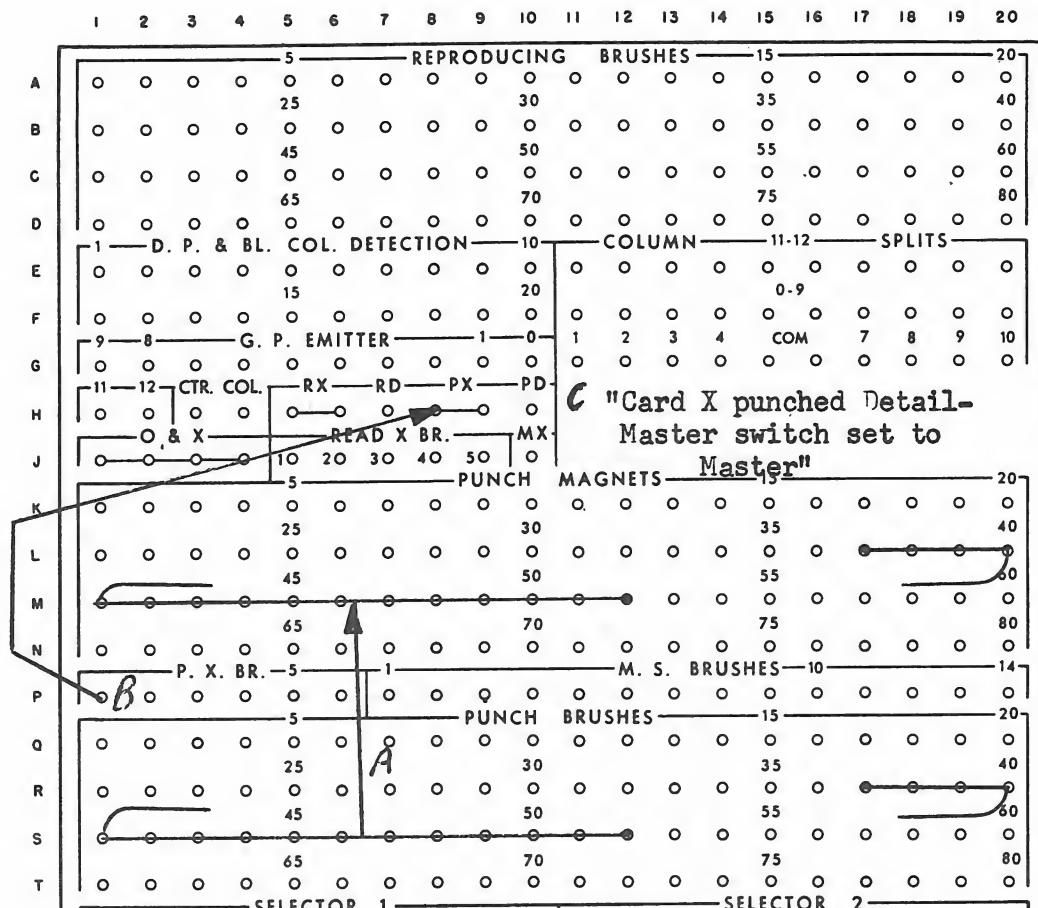
Exercise 1 — Solution

Notes on Exercise 1

A. c.c. 37-52 are wired routinely for gang punching.

B. Punch X Brush is set to read c.c. 10. Punching will be suspended for all X10 master cards.

C. The functional switch called "Card X punched Detail-Master" is in the OFF or Master position.
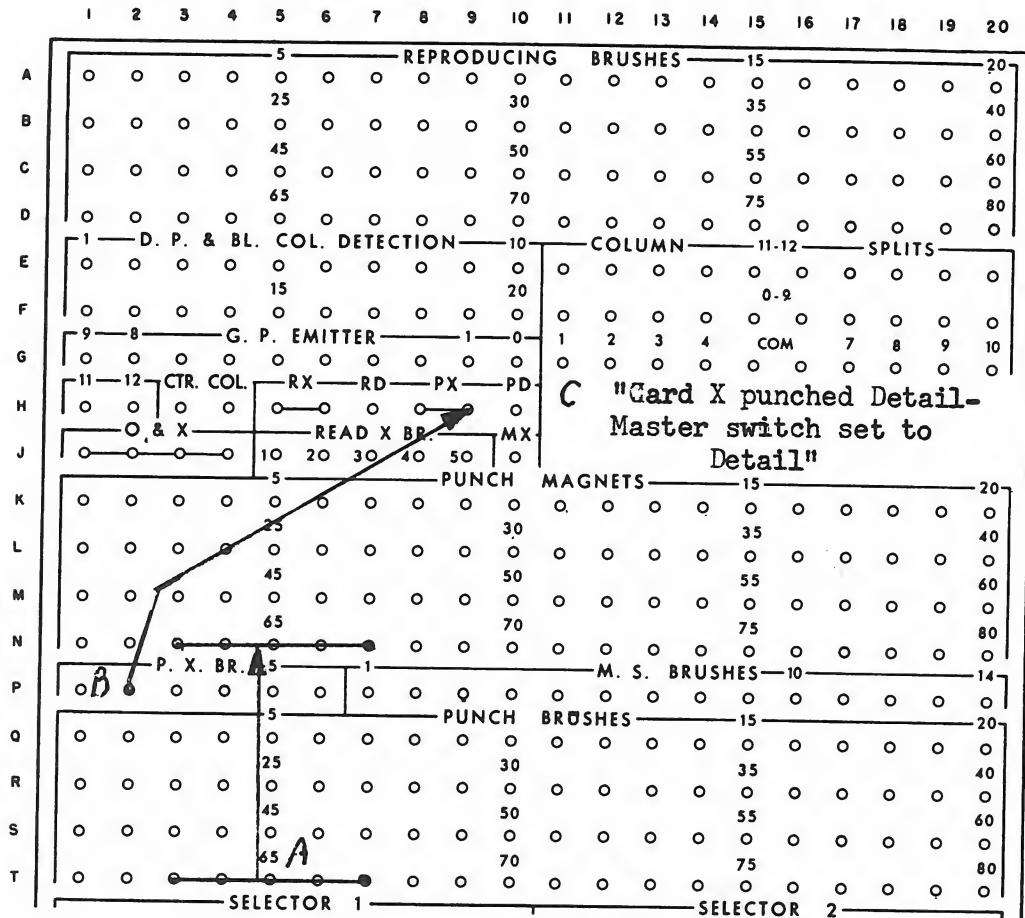
Exercise 2 — Solution

Notes on Exercise 2

A. c.c. 63-67 are wired routinely for gang punching.

B. Punch X Brush 2 is set to read c.c. 36. The impulse from this brush is wired to the PX hub to suspend punching for NX 36 master cards.

C. The functional switch called "Card X punched Detail-Master" is in the ON or Detail position. This is what tells the machine to suspend punching for the NX cards.
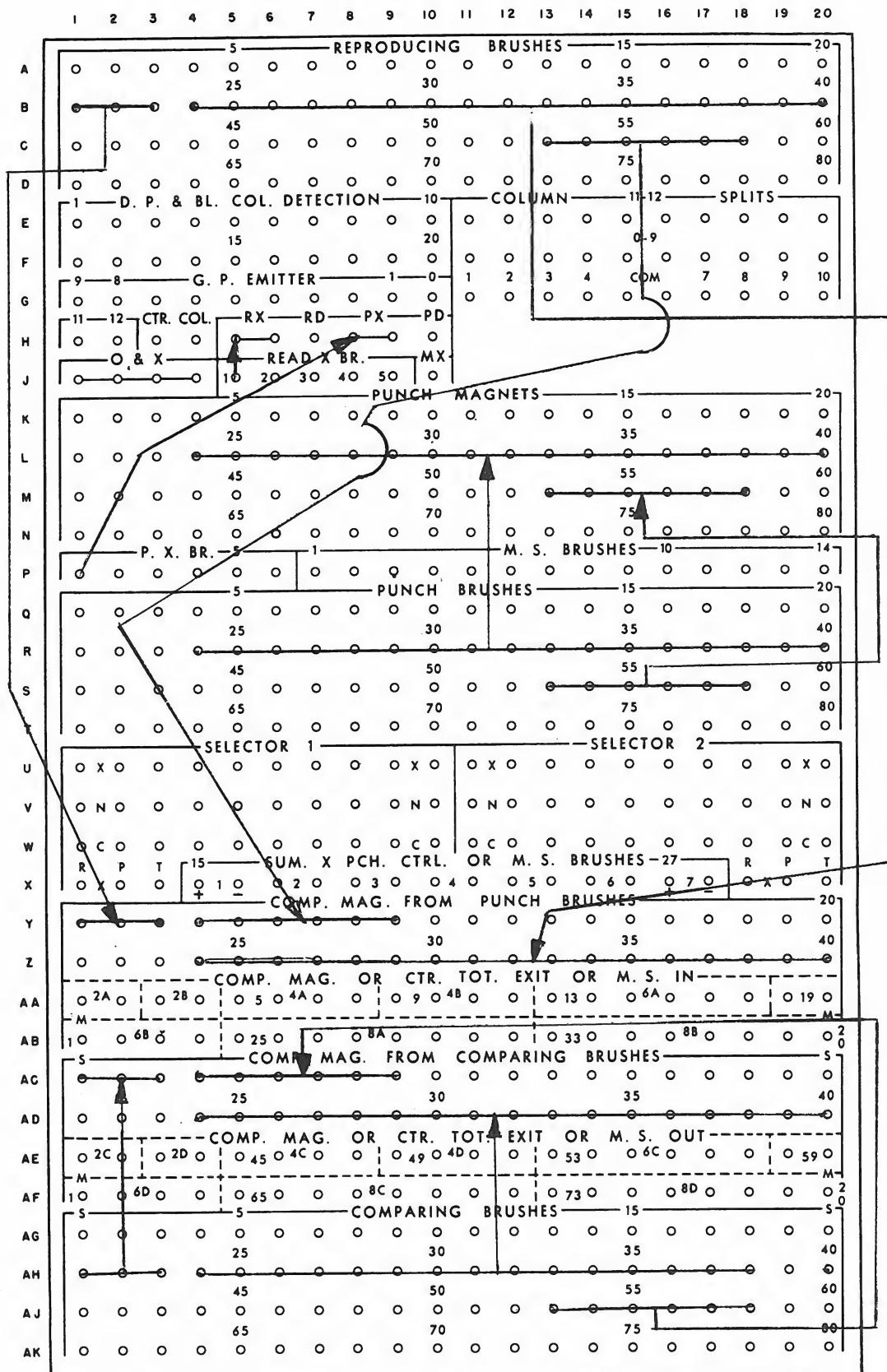
Detail-Master switch set to Detail. G.P. Comp Switch ON

Exercise 3 — Solution
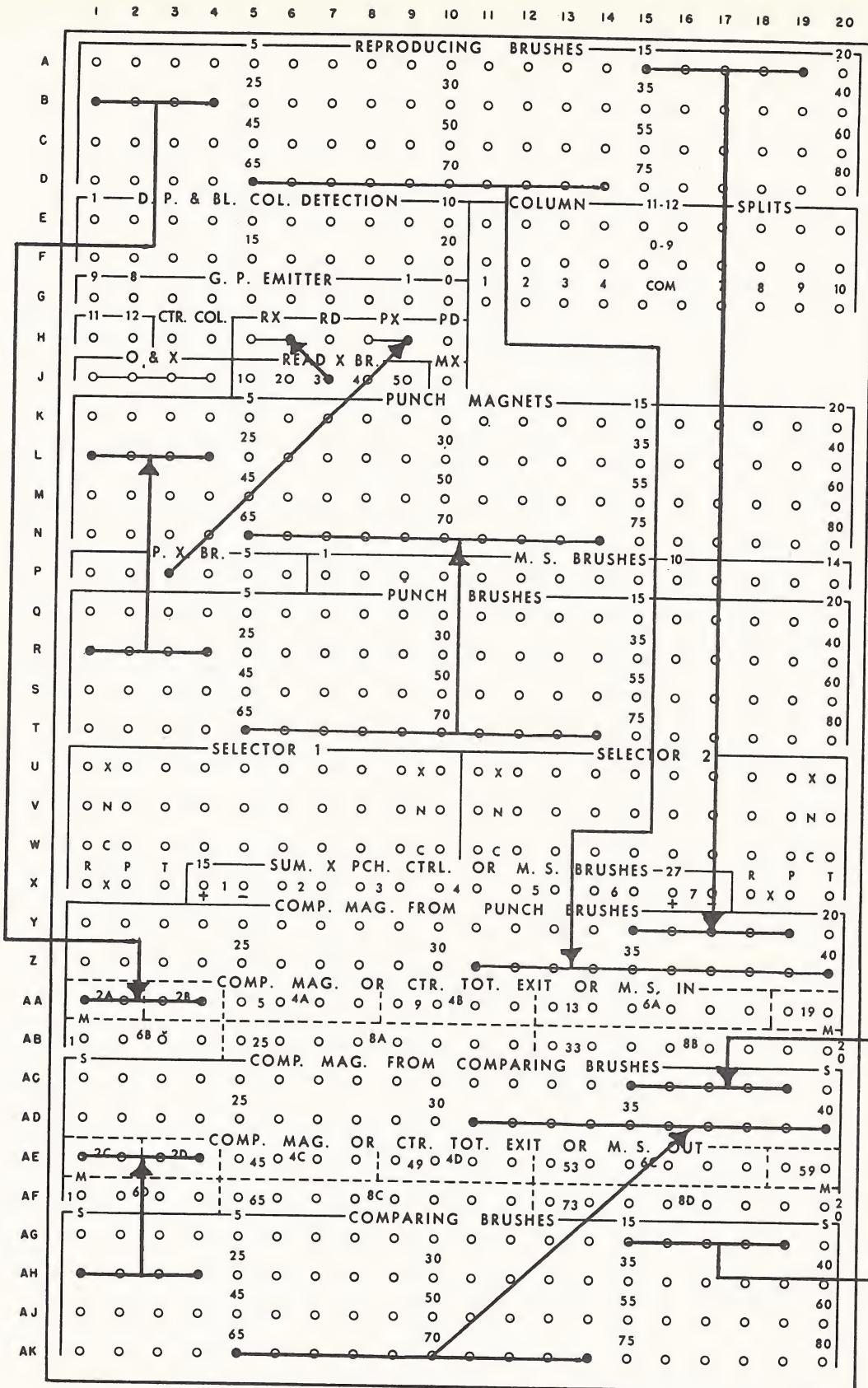
Detail-Master switch set to Master- G.P. Comp. switch ON

Exercise 4 — Solution
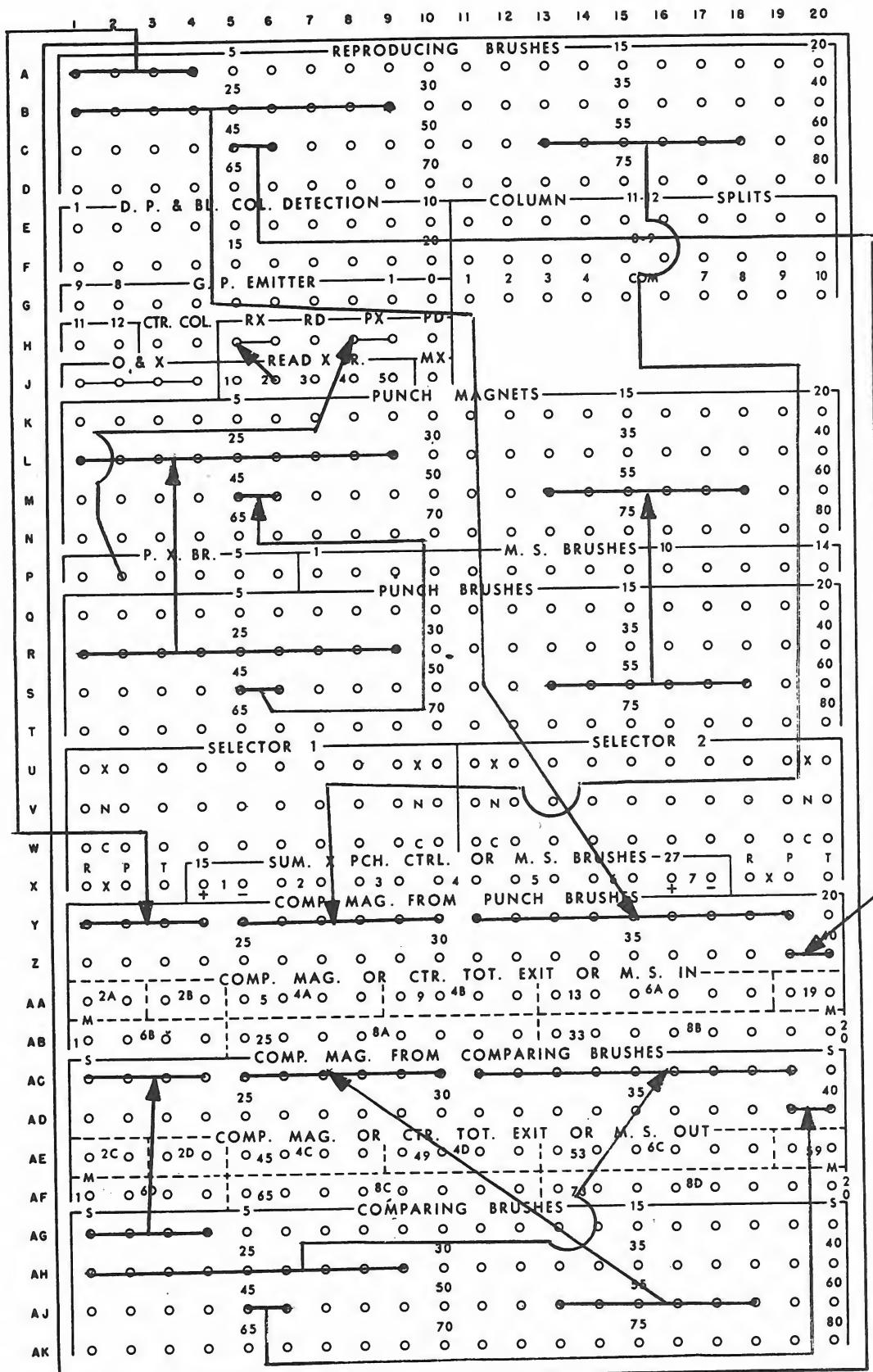
Detail–Master Switch set to Master – G.P. Comp. switch ON

Exercise 5 — Solution

INTERNATIONAL BUSINESS MACHINES CORPORATION
513—514 AUTOMATIC REPRODUCING PUNCH, CONTROL PANEL
FOR SUMMARY PUNCHING — ALPHABETIC ACCOUNTING MACHINE

IBM®

Form X24-9188-9
Printed in U.S.A.

Control panel wiring chart. Column numbers 1–20 across the top.

Row labels and section headings:
- A–D: 5 — REPRODUCING BRUSHES — 15 — 20 (25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- E: 1 — D. P. & BL. COL. DETECTION — 10 — COLUMN — 11·12 — SPLITS
- F: 15 — 20 — 0-9
- G: 9 — 8 — G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10
- H: 11 — 12 — CTR. COL. — RX — RD — PX — PD
- J: O & X — READ X BR. — MX — 10 20 30 40 50
- K–N: 5 — PUNCH MAGNETS — 15 — 20 (25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- P: P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14
- Q–T: 5 — PUNCH BRUSHES — 15 — 20 (25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80)
- U–X: SELECTOR 1 — SELECTOR 2
- U: X O — X O — X O — X O
- V: N O — N O — N O
- W: C O — C O — C O — C O
- X: R P T — 15 — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T; X O — 1 O — 2 O — 3 O — 4 O — 5 O — 6 O — 7 O — X O
- Y: COMP. MAG. FROM PUNCH BRUSHES — 20
- Z: 25 — 30 — 35 — 40
- AA: COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN; 2A — 2B — 5 — 4A — 9 — 4B — 13 — 6A — 19 — M
- AB: 1 — 6B — 25 — 8A — 33 — 8B — 20; M
- AC: S — COMP. MAG. FROM COMPARING BRUSHES — S
- AD: 25 — 30 — 35 — 40
- AE: COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT; 2C — 2D — 45 — 4C — 49 — 4D — 53 — 6C — 59 — M
- AF: 1 — 6D — 65 — 8C — 73 — 8D — 20; M
- AG: S — 5 — COMPARING BRUSHES — 15 — S
- AH: 25 — 30 — 35 — 40
- AJ: 45 — 50 — 55 — 60
- AK: 65 — 70 — 75 — 80

Left side panel:

NOTES

X OR DIGIT

CARD NAME OR FUNCTION

BLANK COLUMN CHECK SWITCHES: 1 2 3 4 5 6 7 8 9 10 — OFF / ON

		X OR DIGIT

ELECTRO NO.

REPRODUCE — OFF / ON
SEL REPD AND GP COMP — OFF / ON
CARD X PUNCHED — MSTR / DET
MARK SENSING — OFF / ON
MASTER CARD PUNCHING — OFF / ON

SWITCHES

DEPT.
NO.
NAME
USE

INTERNATIONAL BUSINESS MACHINES CORPORATION
513—514 AUTOMATIC REPRODUCING PUNCH, CONTROL PANEL
FOR SUMMARY PUNCHING — ALPHABETIC ACCOUNTING MACHINE

IBM

Form X24-9188-9
Printed in U.S.A.

Column numbers: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Row A–D: 5 — REPRODUCING BRUSHES — 15 — 20 / 25 30 35 40 / 45 50 55 60 / 65 70 75 80

Row E: 1 — D. P. & BL. COL. DETECTION — 10 — COLUMN — 11-12 — SPLITS
Row F: 15 20 0-9
Row G: 9 — 8 — G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10
Row H: 11 — 12 — CTR. COL. — RX — RD — PX — PD
Row J: O & X — READ X BR. — MX / 10 20 30 40 50

Row K–N: 5 — PUNCH MAGNETS — 15 — 20 / 25 30 35 40 / 45 50 55 60 / 65 70 75 80

Row P: P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14

Row Q–T: 5 — PUNCH BRUSHES — 15 — 20 / 25 30 35 40 / 45 50 55 60 / 65 70 75 80

Row U: SELECTOR 1 — SELECTOR 2 / X X X X
Row V: N N N N
Row W: C C C C
Row X: R P T 15 — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T / X 1 2 3 4 5 6 7 X / + − + −

Row Y–Z: COMP. MAG. FROM PUNCH BRUSHES — 20 / 25 30 35 40

Row AA: COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN
2A 2B 5 4A 9 4B 13 6A 19 / M M
Row AB: 1 6B 25 8A 33 8B 2 0

Row AC–AD: COMP. MAG. FROM COMPARING BRUSHES / 25 30 35 40

Row AE: COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT
2C 2D 45 4C 49 4D 53 6C 59 / M M
Row AF: 1 6D 65 8C 73 8D 2 0

Row AG–AK: 5 — COMPARING BRUSHES — 15 / 25 30 35 40 / 45 50 55 60 / 65 70 75 80

NOTES

CARD NAME OR FUNCTION

X OR DIGIT: 1 2 3 4 5 6 7 8 9 10

BLANK COLUMN CHECK SWITCHES: 1 2 3 OFF ON

ELECTRO NO.

REPRODUCE
SEL REPD AND GP COMP
CARD X PUNCHED
MARK SENSING
MASTER CARD PUNCHING

OFF OFF MSTR OFF OFF
ON ON DET ON ON

SWITCHES

DEPT.
NO.
NAME
USE

INTERNATIONAL BUSINESS MACHINES CORPORATION
513—514 AUTOMATIC REPRODUCING PUNCH, CONTROL PANEL
FOR SUMMARY PUNCHING — ALPHABETIC ACCOUNTING MACHINE

IBM

Form X24-9188-9
Printed in U.S.A.

Control panel wiring chart. Row and column labels (rows A–AK; columns 1–20) with the following section headings:

- REPRODUCING BRUSHES
- D. P. & BL. COL. DETECTION — COLUMN — 11-12 — SPLITS
- G. P. EMITTER
- CTR. COL. — RX — RD — PX — PD
- O & X — READ X BR. — MX
- PUNCH MAGNETS
- P. X. BR. — M. S. BRUSHES
- PUNCH BRUSHES
- SELECTOR 1 — SELECTOR 2
- SUM. X PCH. CTRL. OR M. S. BRUSHES
- COMP. MAG. FROM PUNCH BRUSHES
- COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN
- COMP. MAG. FROM COMPARING BRUSHES
- COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT
- COMPARING BRUSHES

Left-hand side panel columns:

NOTES

CARD NAME OR FUNCTION

X OR DIGIT — 1 2 3 4 5 6 7 8 9 10

BLANK COLUMN CHECK SWITCHES — 1 2 3 — OFF / ON

ELECTRO NO.	REPRODUCE	SEL REPD AND GP COMP	CARD X PUNCHED	MARK SENSING	MASTER CARD PUNCHING
OFF	OFF	OFF	MSTR	OFF	OFF
ON	ON	ON	DET	ON	ON

SWITCHES

NAME — USE — DEPT. — NO.

ELECTRONIC COMPUTER
PROGRAMMING INSTITUTE

IBM®

NOTES

DEPT.

NO.

X OR DIGIT

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

CARD NAME OR FUNCTION

BLANK COLUMN CHECK SWITCHES — OFF / ON

REPRODUCE
SEL REPD AND GP COMP
CARD X PUNCHED
MARK SENSING
MASTER CARD PUNCHING

ELECTRO NO.

	OFF	ON
REPRODUCE	OFF	ON
SEL REPD AND GP COMP	OFF	ON
CARD X PUNCHED	MSTR	DET
MARK SENSING	OFF	ON
MASTER CARD PUNCHING	OFF	ON

SWITCHES

NAME
USE

Panel labels:

REPRODUCING BRUSHES — 5 — 15 — 20
(rows A–D, columns 1–20, with numbers 25 30 35 40 / 45 50 55 60 / 65 70 75 80)

D. P. & BL. COL. DETECTION — 1 ... 10 — COLUMN — 11-12 — SPLITS
15 ... 20 ... 0-9
9 8 — G. P. EMITTER — 1 0 — 1 2 3 4 COM 7 8 9 10
11 12 — CTR. COL. — RX — RD — PX — PD
O & X — READ X BR. — MX
10 20 30 40 50

PUNCH MAGNETS — 5 — 15 — 20
(rows K–N, with numbers 25 30 35 40 / 45 50 55 60 / 65 70 75 80)

P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14

PUNCH BRUSHES — 5 — 15 — 20
(rows Q–T, with numbers 25 30 35 40 / 45 50 55 60 / 65 70 75 80)

SELECTOR 1 — SELECTOR 2
X X X X
N N N
C C C
R P T — 15 — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T
X 1 O 2 O 3 O 4 O 5 O 6 O 7 X

COMP. MAG. FROM PUNCH BRUSHES — 20
(rows Y–Z, with numbers 25 30 35 40)

COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN
2A 2B 5 4A 9 4B 13 6A 19
M
1 6B 25 8A 33 8B 20
S

COMP. MAG. FROM COMPARING BRUSHES — S
(rows AC–AD, with numbers 25 30 35 40)

COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT
2C 2D 45 4C 49 4D 53 6C 59
M
1 6D 65 8C 73 8D 20
S

COMPARING BRUSHES — 5 — 15 — S
(rows AG–AK, with numbers 25 30 35 40 / 45 50 55 60 / 65 70 75 80)

Column headers: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Row labels: A B C D E F G H J K L M N P Q R S T U V W X Y Z AA AB AC AD AE AF AG AH AJ AK

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION
513—514 AUTOMATIC REPRODUCING PUNCH, CONTROL PANEL
FOR SUMMARY PUNCHING — ALPHABETIC ACCOUNTING MACHINE

Form X24-9188-9
Printed in U.S.A.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

A — 5 — REPRODUCING BRUSHES — 15 — 20
B   25   30   35   40
C   45   50   55   60
D   65   70   75   80

E — 1 — D. P. & BL. COL. DETECTION — 10 — COLUMN — 11-12 — SPLITS
F   15   20   0-9
G — 9 — 8 — G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10
H — 11 — 12 — CTR. COL. — RX — RD — PX — PD
J — O & X — READ X BR. — MX — 10 20 30 40 50

K — 5 — PUNCH MAGNETS — 15 — 20
L   25   30   35   40
M   45   50   55   60
N   65   70   75   80

P — P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14
Q — 5 — PUNCH BRUSHES — 15 — 20
R   25   30   35   40
S   45   50   55   60
T   65   70   75   80

U — SELECTOR 1 — SELECTOR 2
  X O   X O   X O   X O
V N O   N O   N O   N O
W C O   C O   C O   C O
X R P T — 15 — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T
   X O   + 1 — 2 — 3 — 4 — 5 — 6 — 7 +   X O
Y — COMP. MAG. FROM PUNCH BRUSHES — 20
Z   25   30   35   40

AA — COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN —
   2A   2B   5   4A   9   4B   13   6A   19
   M   M
AB 1   6B   25   8A   33   8B   2 0
AC — S — COMP. MAG. FROM COMPARING BRUSHES — S
AD   25   30   35   40
AE — COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT —
   2C   2D   45 4C   49 4D   53   6C   59
   M   M
AF 1   6D   65   8C   73   8D   2 0
AG — S — 5 — COMPARING BRUSHES — 15 — S
AH   25   30   35   40
AJ   45   50   55   60
AK   65   70   75   80

NOTES

DEPT.

NO.

NAME

USE

Left panel (sideways):

ELECTRO NO.

CARD NAME OR FUNCTION

X OR DIGIT

X OR DIGIT | 10 9 8 7 6 5

BLANK COLUMN CHECK SWITCHES | 1 2 3 4 5 | OFF | ON

	OFF	ON
REPRODUCE	OFF	ON
SEL REPD AND GP COMP	OFF	ON
CARD X PUNCHED	MSTR	DET
MARK SENSING	OFF	ON
MASTER CARD PUNCHING	OFF	ON

SWITCHES

IBM

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NOTES

CARD NAME OR FUNCTION

X OR DIGIT

ELECTRO NO.

	1	2	3	4	5	6	7	8	9	10

BLANK COLUMN CHECK SWITCHES — OFF / ON

REPRODUCE

OFF	ON	SEL REPD AND GP COMP
OFF	ON	CARD X PUNCHED
MSTR	DET	MARK SENSING
OFF	ON	MASTER CARD PUNCHING
OFF	ON	

SWITCHES

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

A — 5 — REPRODUCING BRUSHES — 15 — 20
B — 25 — 30 — 35 — 40
C — 45 — 50 — 55 — 60
D — 65 — 70 — 75 — 80

E — 1 — D. P. & BL. COL. DETECTION — 10 — COLUMN — 11-12 — SPLITS
F — 15 — 20 — 0-9
G — 9 — 8 — G. P. EMITTER — 1 — 0 — 1 2 3 4 COM 7 8 9 10
H — 11 — 12 — CTR. COL. — RX — RD — PX — PD
J — O & X — READ X BR. — MX — 10 20 30 40 50

K — 5 — PUNCH MAGNETS — 15 — 20
L — 25 — 30 — 35 — 40
M — 45 — 50 — 55 — 60
N — 65 — 70 — 75 — 80

P — P. X. BR. — 5 — 1 — M. S. BRUSHES — 10 — 14

Q — 5 — PUNCH BRUSHES — 15 — 20
R — 25 — 30 — 35 — 40
S — 45 — 50 — 55 — 60
T — 65 — 70 — 75 — 80

U — SELECTOR 1 — SELECTOR 2
V
W — R P T
X — SUM. X PCH. CTRL. OR M. S. BRUSHES — 27 — R P T
Y — COMP. MAG. FROM PUNCH BRUSHES — 20
Z — 25 — 30 — 35 — 40

AA — COMP. MAG. OR CTR. TOT. EXIT OR M. S. IN
AB — COMP. MAG. FROM COMPARING BRUSHES

AC
AD — 25 — 30 — 35 — 40

AE — COMP. MAG. OR CTR. TOT. EXIT OR M. S. OUT
AF

AG — 5 — COMPARING BRUSHES — 15
AH — 25 — 30 — 35 — 40
AJ — 45 — 50 — 55 — 60
AK — 65 — 70 — 75 — 80

DEPT.

NO.

NAME

USE

INSTRUCTIONS. Your examinations are important to you as they indicate how well you understand the lesson material. Be sure to allow yourself enough time to complete the examination. Read each question carefully and be sure you understand it. Mark your answers in the proper box. Review the exam to be sure that all questions have been answered.

1. How many Punch X Brushes are there?
   a. 1
   b. 5
   c. 80
   d. 6

2. How many Read X Brushes are there?
   a. 1
   b. 5
   c. 80
   d. 6

3. In an intersperse gang punch job, punching takes place at which station?
   a. Reproducing brushes
   b. Punch Magnets
   c. Punch brushes
   d. Comparing brushes

4. In an intersperse gang punch job, which two stations are wired to the comparing magnets?
   a. Comparing brushes and reproducing brushes
   b. Comparing brushes and reading brushes
   c. Reading brushes and reproducing brushes
   d. All the above are incorrect

5. In an intersperse gang punch job where the master cards contain the control X, which of the switch settings below is correct? Assume that you plan to verify the job.
   a. Reproduce switch OFF; G.P. Comp. switch OFF; Detail-Master switch set to Master.
   b. Reproduce switch ON; G.P. Comp. switch ON; Detail-Master switch set to Master.
   c. Reproduce switch OFF; G.P. Comp. switch ON; Detail-Master switch set to Master.
   d. Reproduce switch OFF; G.P. Comp. switch ON; Detail-Master switch set to Detail.

6. The Punch X Brush impulse is wired to which of the following hubs?
   a. RX
   b. PX
   c. Comparing magnet 1
   d. Punching magnet 1

Answer the following questions True or False. If True, place an X in Box A; if False, place an X in Box B.

7. With the G.P. Comp. switch ON, both feeds are synchronized.

8. The Read X brush impulse is wired to the RX hub.

9. The Detail-Master switch is set to Detail when the control X punch is in the Master cards.

10. When punching NX to X, the control X is in the Master cards.

11. It is possible to intersperse gang punch and compare the operation of the machine at the same time.

12. In an X to NX intersperse gang punch job, a master card which does not contain an X control punch will be laced.

Refer to Figure 15 and answer the following questions True or False.

13. Assume that the functional switches are set correctly. This is an X to NX intersperse gang punch job.

14. Field A is wired correctly to intersperse gang punch c.c. 16-20.

15. Field D is wired correctly to intersperse gang punch c.c. 23-25.

16. Field B is being reproduced and compared correctly.

Assume that the wiring from Punch X brush to PX and from Read X brush to RX is correct. Also assume that our Read X and Punch X brushes are set on the same columns as they have been throughout this lesson.

17. The master cards have both an X in c.c. 10 and an X in c.c. 65.

18. The wiring to compare Field B is correct.

19. The wiring to compare Field C is correct.

20. Assume that the wiring to gang punch c.c. 23-25 was correct. Question: the wiring to compare c.c. 23-25 is correct.
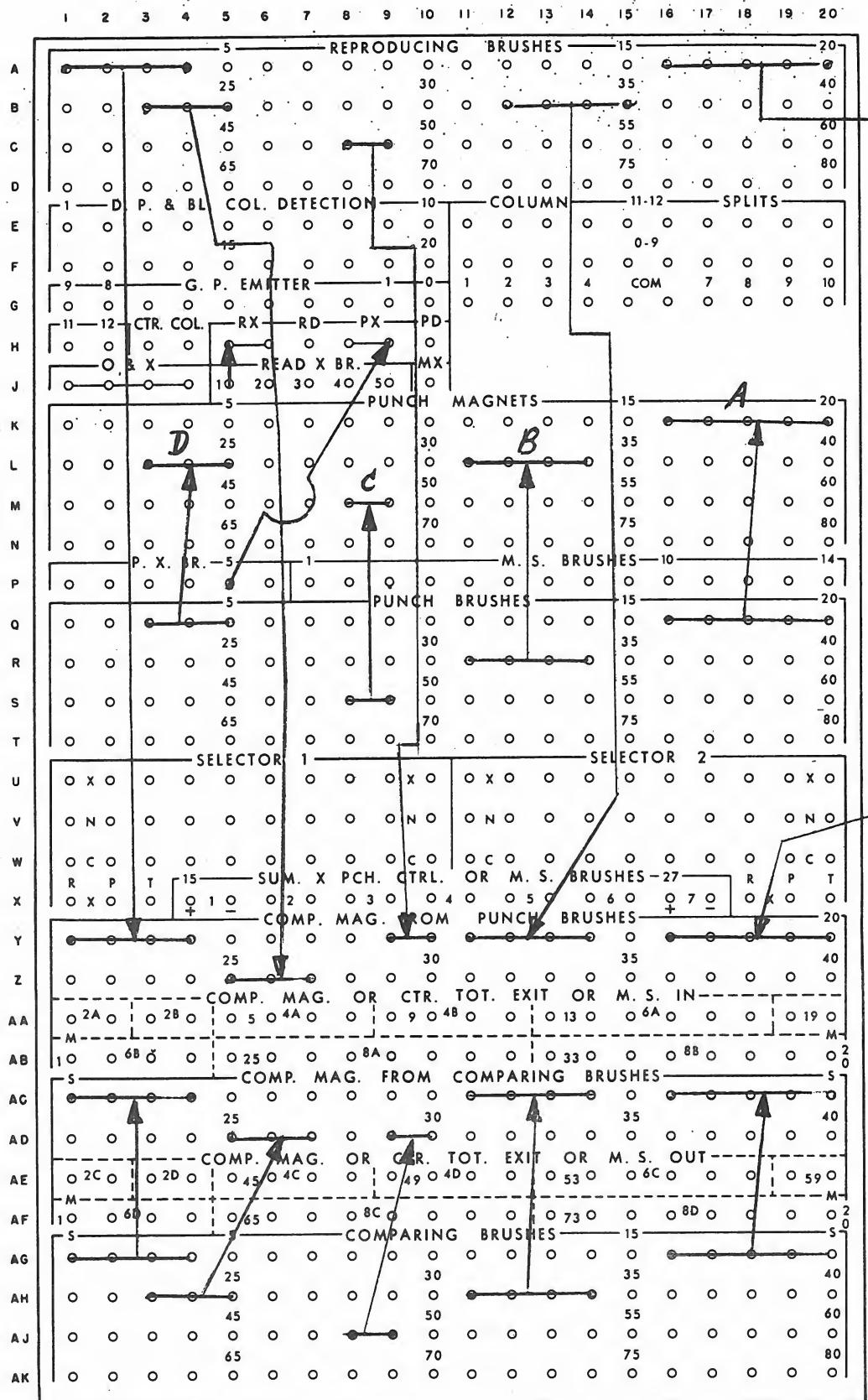
Detail-Master switch set to Master; G.P. Comp. switch ON

Figure 15.